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SOUTH RESERVOIR DAM A.. (U) CORPS OF ENGINEERS WALTHAM
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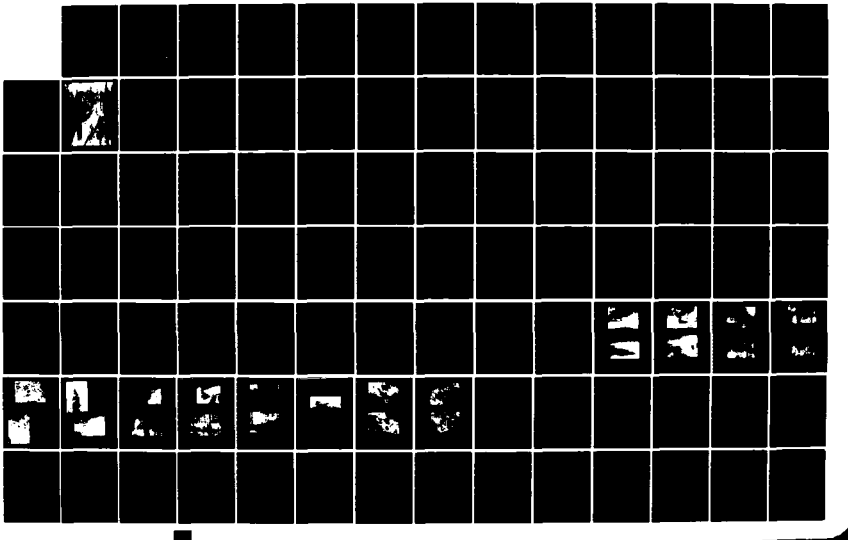
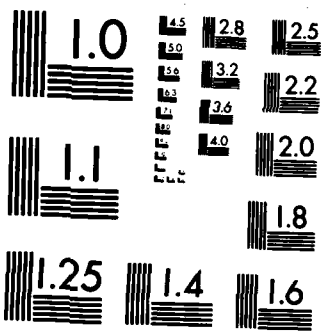




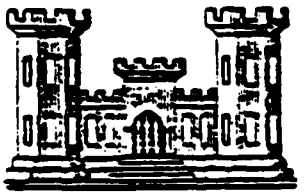
MASSACHUSETTS COASTAL AREA

WINCHESTER, MASSACHUSETTS

SOUTH RESERVOIR DAM AND DIKES

MAIN DAM ——— MA 00453
EAST DIKE ——— MA 01278
WEST DIKE ——— MA 01279

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

APRIL 1980

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Massachusetts Coastal Area
Winchester, Massachusetts
Offstream tributary to Mystic River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The main dam is a 950 foot long, 38 foot hydraulic height earth fill embankment stucture with a 25 foot long concrete spillway at the right abutment. There are also two earthfill embankment dikes. The west dike is about 200 ft. long and has a height of 6 ft. The east dike is 100 ft. long and about 13.5 ft. in height. The dam is judged to be in generally good condition and the dikes are in fair condition. The size classification is intermediate and the hazard potential is high.

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REPLY TO
ATTENTION OF:
NEDED

JUN 19 1980

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the South Reservoir Dam and Dikes Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Town of Winchester, Massachusetts.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INVESTIGATION REPORT
BRIEF ASSESSMENT

Identification No.:	MA 00453, Main Dam; MA 01278, East Dike; MA 01279, West Dike
Name of Dam:	South Reservoir Dam and Dikes
Town:	Winchester
County and State:	Middlesex County, Massachusetts
Stream:	Offstream Tributary to Mystic River
Date of Inspection:	October 24, 1979

The main dam is a 950 foot long, 38 foot hydraulic height earth fill embankment structure with a 25 foot long concrete spillway at the right abutment. There are also two earth fill embankment dikes. The west dike is about 200 feet long and has a hydraulic height of six feet. The east dike is 100 feet long with a hydraulic height of about 13.5 feet.

There were no indepth engineering data available for review. The condition of the dam and dikes was primarily evaluated by visual inspection, past performance history and sound engineering judgement. Based on the visual inspection the dam was judged to be in generally good condition and the dikes were judged to be in generally fair condition. Brush and trees were observed on the dam and dike embankments and vehicle ruts were observed at the crests. An erosion gully was observed in the upstream slope of the east dike.

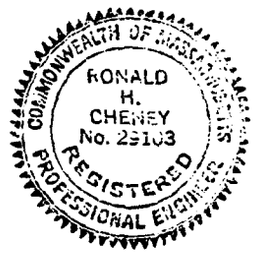
The project has a size classification of intermediate and a hazard potential classification of high. Based upon Corps Guide-

lines, the test flood is the PMF. Test flood inflow from the 0.76 square mile drainage area is 2,280 cfs. The spillway can pass the routed test flood outflow, with and without flashboards. The dam and dikes are not overtopped. The reservoir is surcharged to elevation 162.3, 1.2 foot below the top of dam, without flashboards. The routed test flood outflow is 200 cfs.

It is recommended that the Owner engage a qualified registered professional engineer to perfórm the following: determine procedures for removing trees growing on the dam and dikes including assistance in selecting material for backfilling voids left due to the removal of root systems; a seismic investigation of the dam and dikes.

Furthermore, the Owner should institute remedial measures which include: develop a formal warning system for alerting downstream impact areas in case of emergency; remove brush from the slopes of the dam and dikes and from the area within 10 feet of the toe; repair vehicle ruts on the crest and establish protective vegetation cover; repair the erosion gully at the east dike; remove brush and small trees from the spillway channel; remove fallen trees from the 30 inch waste pipe outlet channel; clean and maintain the waste pipe outlet; insure that the waste pipe and water supply pipe control valves are operable; establish a formal maintenance procedure; fill in animal holes as they appear; and institute a program of annual technical inspection.

The recommendations and remedial measures should be implemented by the Owner within one year after receipt of this Phase I Investigation Report.



Ronald H. Cheney, P.E.
Vice President

Hayden, Harding & Buchanan, Inc.
Boston, Massachusetts

This Phase I Inspection Report on South Reservoir Dam and Dikes has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

Joseph W. Finegan

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to

assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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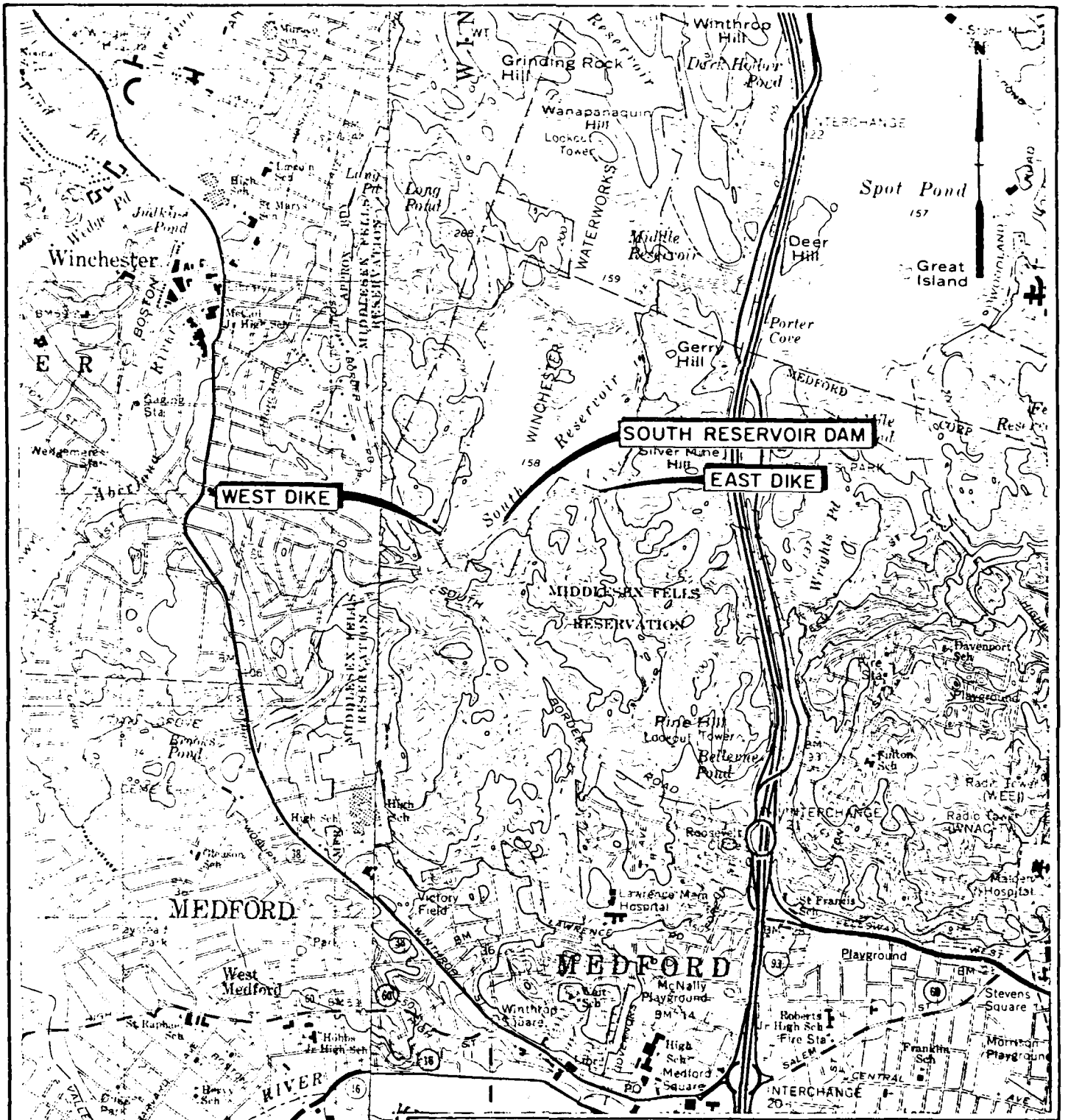
APPENDIXES



HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SOUTH RESERVOIR DAM & DIKES
LOCATION PLAN

WINCHESTER MASSACHUSETTS

SCALE 1:24000 & 1:25000

DATE MARCH, 1980

PHASE I
NATIONAL DAM INSPECTION PROGRAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Hayden, Harding & Buchanan, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued Hayden, Harding & Buchanan, Inc. under a letter of 24 October 1979 from William E. Hodgson Jr., Colonel, Corps of Engineers. Contract No. DACW 33-80-C-0006 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

South Reservoir Dam is located in the northwestern section of the Town of Medford, approximately 4,500 feet south of the intersection of the Stoneham-Medford-Winchester town lines. The dam is shown on the Boston North, Massachusetts Quadrangle map having approximate coordinates of North 42°26'25", West 71°07'13".

b. Description of Dam and Appurtenances

South Reservoir Dam is a 950± foot long, 38 foot hydraulic height, earth embankment structure having a masonry intake structure and a 25 foot long riprap and gravel lined emergency spillway. There is also a 6 foot high, 200 foot long west dike located 300 feet to the right of the main dam and a 13.5 foot high, 100 foot long east dike located approximately 1,300 feet to the left of the main dam. Both dikes are earth embankments built across low areas between the hills surrounding the reservoir.

The upstream side slope of the main dam earth embankment is riprap lined to within 4 to 5 feet of the crest and is inclined at approximately 1.5H:1V, photograph 4 (Appendix C). The downstream side slope is lined with vegetation and inclined at about 1.5H:1V. There is a 14 foot wide berm located approximately 25 feet downstream of the crest. This berm is used as an access road as shown by photograph 14. The crest is approximately 12 feet wide and is also used as an access road.

The intake structure is a 10± foot square masonry structure with a steel truss, wood deck service bridge, photograph 15.

It is comprised of granite blocks to the level of the crest of dam with a brick masonry gatehouse above this level. It contains manually operated gates to regulate the flow through a 24 inch water supply pipe and 30 inch waste pipe. The 24 inch pipe connects into the Winchester water supply system. The waste pipe discharges at a stone masonry headwall outlet structure (see photographs 9 and 10) located about 45 feet downstream of the toe of dam.

The spillway structure, located about 700 feet to the right of the gatehouse, is about 25 feet long and has 2 foot high concrete weir. There is a concrete and steel beam bridge over the spillway which is used as an access road (see photographs 1 and 3). A 3 foot wide channel divides the weir into two sections of 8 and 14 feet in length. There are provisions for 2 feet of stoplogs in this channel, and 6 inches of flashboards atop the weir crest, which has an elevation of 160.5. The bottom of the roadway bridge is about 6.8 feet above the weir crest. The spillway approach channel (see photograph 3) has riprapped side slopes inclined at 1.5H:1V. The spillway discharge channel is relatively flat for approximately ninety feet. Then the channel drops at a slope of 1H:1V for about 15 feet, and eventually flows into a small brook.

There is another reservoir located immediately to the north known as Middle Reservoir. There is an access road dike separating the South Reservoir from the Middle Reservoir. This dike is divided into two sections by a natural high area and contains culverts to regulate flow between the two reservoirs.

c. Size Classification

Corps guidelines for a size classification of intermediate have a storage capacity range of between 1000 to 50000 a-f and a hydraulic height range of between 40 to 100 feet.

The dam has an intermediate size classification based on its approximate storage capacity of 1,850 acre-feet. Its hydraulic height is about 38 feet.

d. Hazard Classification

The hazard potential due to main dam failure flooding is classified as high. Based on Corps Guidelines, the calculated outflow from dam failure is 41,400 cfs. The impact area downstream of the dam includes areas of substantial residential development. Flood stages could reach depths of up to 10 feet. It is estimated that in excess of 150 homes are located within the impact area. There is a significant potential for the loss of more than a few lives due to dam failure.

Failure of the west dike would result in a high hazard potential. Based on Corps Guidelines, the outflow of the assumed test flood would be 700 cfs. Flooding depths of 2 to 3 feet would occur in the residential areas downstream. Between 5 and 10 homes could suffer damage as a result of the failure of the west dike. There is a potential for the loss of more than a few lives due to failure of the west dike.

A high hazard potential would also occur as a result of the failure of the east dike. Several homes located along South Border Road, about 5,000 feet downstream, could be flooded by 2 to 3 feet of water. Beyond this point it is estimated that 5

homes located to the west of Roosevelt Circle could be flooded by about 5 feet of water. At least 5 more homes could be flooded by 1 to 2 feet of water in the area beyond the Roosevelt Circle Interchange. There is a potential for for the loss of more than a few lives due to failure of the east dike.

e. Ownership

The dam is owned by the Town of Winchester, Massachusetts.

f. Operator

The dam is maintained by the Winchester Department of Public Works. Mr. Tanazuck of the Department of Public Works is the designated caretaker. The address is 15 Lake Street, Winchester, Massachusetts 01890. (Telephone 617-729-3503).

g. Purpose of Dam

The purpose of the dam has always been public water supply.

h. Design and Construction History

No records were found to indicate when or by whom the dam was built or when any subsequent repairs or modifications were made.

i. Normal Operating Procedures

The normal pool level of both the South and Middle Reservoirs in the Winchester Water Supply System, is maintained by pumping water into the Middle Reservoir from nearby Spot Pond Reservoir, a part of the MDC water supply system. The water demand exceeds the natural runoff water supply from the drainage area. About 300 to 400 million gallons per year are pumped from

Spot Pond. The water levels for the South and Middle Reservoirs are normally kept at elevation 155 to 157. Water is released from the Middle Reservoir to the South Reservoir to maintain its level.

At the gatehouse, the control valve for the 30 inch waste line is kept closed. Its functionability is reported to be unknown. The valve for the 24 inch water supply line is always kept open and its operating condition is unknown.

1.3 Pertinent Data

a. Drainage Area

The South Reservoir is one of three reservoirs comprising the Winchester Water Works. The other impoundments, known as the Middle and North Reservoirs are located directly to the north of South Reservoir. These impoundments are used for water supply purposes. The Middle Reservoir has two outlets into South Reservoir, effectively making these reservoirs act as a unit. The drainage area of these two reservoirs is 0.76 square miles (486 acres) and is generally hilly and forested with little development. The majority of the area is within the MDC's Middlesex - Falls Reservation. The inlet brooks are relatively steep and short.

South Reservoir outlets to a small brook that flows southward to the Mystic River. Middle Reservoir is separated from South Reservoir by a man-made dike used as an access road, formed between a small central natural hill and ridges of high ground on each shore. This dike represents the lowest area surrounding the middle reservoir. Ground elevations along the

dike vary from 168± to 164±.

A 24± inch corrugated metal pipe and a 36± inch reinforced concrete pipe are used to discharge water from Middle Reservoir to South Reservoir. The 24 inch pipe (normally kept closed) has an invert elevation of 158±. Water flows through the man-made access road dike, with a riser section at the upstream end to regulate the level of the Middle Reservoir. The 36 inch is located through a strip of high ground that runs to a small hill which also serves to separate the reservoir. The 36 inch pipe (invert elevation of 158±) has inlet and gaging structures. The inlet structure has provisions for stoplogs. A depth/flow gaging structure is located to the north of the access road. This structure also has provisions for stoplogs. Six feet of stoplogs were found to be in place at this structure during a field inspection.

b. Discharge at Outlet

1. Outlet Works

The outlet works for the South Reservoir consist of a spillway structure and channel, a 30 inch waste drain pipe, and a 24 inch pipe which connects into the Town's water supply system. The inverts of these pipes are not known. Outflow through the waste drain pipe is controlled by a gate located within the gatehouse. The operability of this gate is unknown. The waste pipe discharges from a stone masonry headwall outlet structure located about 45 feet downstream of the toe. The outlet invert is at elevation 120±. If the 30 inch waste drain pipe were useable, its maximum capacity would be at about 150

cfs. The 24 inch pipe could have a maximum capacity of 100 cfs.

The spillway (see photograph 2) consists of a 25 foot long by 8 foot 10 inch high opening beneath a roadway overpass. A 3 foot wide channel separates a 2 foot high concrete weir into two sections of 8 and 14 feet in length. There are provisions for 2 feet of stoplogs in the channel and 6 inches of flashboards on the weir. The 2 foot high weir reduces the vertical clearance under the roadway bridge to 6 feet 10 inches. The invert of the channel is at elevation 158.5± while the elevation of the weir crest is 160.5±.

2. Maximum Known Flood

Records of maximum past floods or reservoir impoundments were not located. Data from the U.S. Weather Bureau indicate that over 14 inches of rainfall occurred in the vicinity of South Reservoir during the period of August 19 to 10, 1955.

3. Ungated Spillway Capacity at Top of Dam

Under normal operating conditions, with the 30-inch waste drain pipe closed and no flashboards in place at the spillway, the spillway capacity is 450 cfs with the reservoir water level at the top of dam, elevation 163.5.

4. Ungated Spillway Capacity at Test Flood

The spillway, with no stoplogs or flashboards in place and the 30-inch waste drain pipe closed, would have a capacity of 200 cfs or 100 percent of the routed test flood outflow. The test flood surcharge elevation would be 162.3 feet.

5. Total Project Discharge at Top of Dam

The total project discharge with the reservoir level

at the top of dam, elevation 163.5, no flashboards in the spillway and the 30-inch waste drain pipe closed would be about 450 cfs.

6. Project Discharge at Test Flood Elevation

The total project discharge for the test flood condition with the 30-inch waste drain pipe open would be approximately 350 cfs, for a reservoir elevation of about 162.6. The total project discharge with this waste drain pipe closed is 200 cfs.

c. Elevation (ft. above NGVD - approximate only)

(1) Streambed at toe of dam ---------- 125.5±

(2) Bottom of cutoff ---------- Unknown

(3) Maximum tailwater ----------Unknown

(4) Normal pool ---------- 158±

(5) Full flood control pool ---------- N/A

(6) Spillway crest ---------- 158.5
top of 2' foot concrete weir 160.5

(7) Design surcharge (Original Design) -------- Unknown

(8) Top of dam ---------- 163.5

(9) Top of East Dike ---------- 163.5

(10) Top of West Dike ---------- 163.5

(11) Test flood surcharge ---------- 162.6±

d. Reservoir (Length in feet; South & Middle Reservoir)

(1) Normal pool (elevation 158) ---------- 7300±

(2) Spillway crest pool ---------- 7600±

(3) Top of dam ---------- 7650±

(4) Test flood pool ---------- 7650±

(5) Flood control pool ---------- N/A

e. Storage (acre-feet; South & Middle Reservoir)

(1)	Normal pool (elevation 158)	1790±
(2)	Spillway crest pool	1850
(3)	Test flood pool	2550
(4)	Top of dam	2720
(5)	Flood control pool	N/A

f. Reservoir Surface (acres; South & Middle Reservoir)

(1)	Normal pool	129
(2)	Spillway crest (elevation 158.5)	133
(3)	Test flood pool	164
(4)	Top of dam	171
(5)	Flood control pool	N/A

g. Dam

		West Dike	East Dike
(1)	Type - gravity, earth embankment	earth embankment	
(2)	Length - 950'	200'	100'
(3)	Height - 38'	6'	13.5'
(4)	Top Width - 12'	15'	32'
(5)	Side Slopes - Approx. 1.5H:1V	2H:1V	1.5H:1V
(6)	Zoning - Unknown	Unknown	
(7)	Impervious Core - Unknown	Unknown	
(8)	Cutoff - Unknown	Unknown	
(9)	Grout curtain - Unknown	Unknown	

h. Diversion and Regulating Tunnel ---------- None

i. Spillway

(1)	Type	broadcrested weir
(2)	Length of weir	25'

(3) Crest elevation (top of concrete weir) --- 160.5 no flashboards
2'x3' channel opening elevation 158.5

(4) Gates ---------- None

(5) U/S Channel ----- 26' wide with 1.5H:1V side slopes

(6) D/S Channel ---------- 26'± wide, with 15' drop at 1H:1V slope 90° downstream of spillway

(7) General ---------- weir has 3' wide by 2' high channel opening which divides it into two sections

j. Regulating Outlets

The regulating outlets for the South Reservoir are the 24 inch water supply pipe and the 30 inch waste pipe. Discharge to the water supply system through the 24 inch pipe or to a brook downstream through the 30 inch waste drain pipe is controlled by manually operated gates located within the gatehouse. The elevations of the intakes for either of these pipes is not known. The outlet for the waste pipe (photographs 9 and 10) is located about 45 feet downstream of the toe of dam. It has an invert elevation of approximately 120 and a stone masonry outlet structure with a 3 foot wide headwall and two 15 foot long sidewalls.

SECTION 2

ENGINEERING DATA

2.1 Design Data

No information was located indicating when or by whom the dam was designed. No indepth design calculations were located.

2.2 Construction Data

No construction data was located for this dam. A stone marker over the door of the gatehouse gives a date of 1890.

2.3 Operation Data

No operational manual exists for this dam.

2.4 Evaluation of Data

a. Availability

No engineering data was located regarding South Reservoir Dam. A State Inspection Report for 1974 was made available at the State Department of Environmental Quality Engineering, Division of Waterways, Boston Office.

b. Adequacy

No indepth engineering data was made available. This, therefore, does not permit structural and hydraulic assessment of the dam from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history, and sound engineering judgement.

c. Validity

The visual inspection of the dam indicated a maximum height of approximately 38 feet and a length of 950 feet. The State Inspection Report indicated a maximum height of 10 feet and a length of 200 feet. The existence of dikes were not indicated within the State Inspection Report.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection included the main dam and the two dikes located to the east and west of the main dam. The water level in the reservoir was about 11.5 feet below the crest of dam at the time of inspection. Although the control gate for the waste pipe is reported to be closed, water was observed within the outlet channel which may indicate leakage.

b. Dam

The dam is an earth embankment about 38 feet high, 950 feet long, and 12 feet wide at the crest. A spillway is located at the right abutment and outlet works are located near the center of the dam. Bedrock outcrops at the left abutment of the dam and in the spillway channel at the right abutment of the dam.

Upstream Slope

The upstream slope of the dam is inclined at about 1.5H:1V and is protected by riprap up to about 4 to 5 feet below the crest, as shown in photograph 4. The riprap is in good condition. The upper 4 to 5 feet of the upstream slope above the riprap is overgrown with brush, and a few small trees are growing on the slope. Minor erosion gullies were noted on the slope at both sides of the service bridge to the brick gatehouse which is located in the reservoir near the center of the dam.

Crest

The crest of the dam is rutted by vehicular traffic, as shown in photograph 5, and bare soil is exposed in the ruts. No evidence of cracking or misalignment of the crest was observed.

Downstream Slope

The downstream slope of the dam is separated into upper and lower portions by a midslope berm, as shown in photographs 12 and 14. The slope is inclined at 1.5H:1V: An unpaved access roadway runs along the midslope of the downstream slope, photograph 6, and a few small animal holes were observed on the slope. The lower portion of the downstream slope is heavily overgrown with brush, and a few small trees are growing on the slope, photographs 7 and 8. Much of the brush on the lower downstream slope consists of new growth from stumps of trees that have been cut in the past. Several minor erosion scarps and gullies (up to 2 to 3 feet wide and 6 to 12 inches deep) were noted on the lower downstream slope. No seepage was observed on the downstream side of the dam.

East Dike

The east dike is an earth embankment about 13.5 feet high, 100 feet long, and 32 feet wide at the crest, located to the east of the main dam.

Upstream Slope

The upstream slope of the dike is inclined at 1.5H:1V and is protected by riprap up to about 4 to 5 feet below the crest, as shown in photograph 22. Brush is growing on the upstream slope above the riprap, as shown in photograph 22. There is an erosion gully approximately 4 feet wide and 2.5 feet deep

on the upstream slope at the left abutment, as shown in photographs 20 and 21.

Crest

A dirt access road runs along the crest of the dike, as shown in photograph 19. No evidence of cracking or misalignment was observed.

Downstream Slope

The downstream slope of the dike is inclined at 1.5H:1V and is shown in photograph 23. There is a 2 to 3 foot high rubble stone wall at the toe of the slope. Several small trees are growing on the downstream slope and at the downstream toe, as shown in photograph 23.

West Dike

The west dike is an earth embankment about 6 feet high, 200 feet long, and 15 feet wide at the crest, located to the west of the main dam.

Upstream Slope

The upstream slope of the west dike is shown in photograph 18. The upper portion of the slope is inclined at 2H:1V down to about 3 feet below the crest. Below this point, the slope becomes relatively flat, forming a broad berm about 3 feet above the toe. The toe of the slope is protected by riprap extending about 2 to 3 feet above the toe. A number of trees are growing on the upstream slope, as shown in photograph 18.

Crest

A dirt access road runs along the crest of the west dike and the surface of the crest is rutted from vehicular traffic,

photograph 17. No evidence of cracking or misalignment was observed.

Downstream Slope

The downstream slope of the west dike is inclined at 2H:1V. A number of large trees (up to 2.5 feet diameter) are growing on the slope and at the downstream toe, as shown in photograph 16. Several of these trees appear to be dead. Several large exposures of rock were observed on the downstream slope, as shown in photograph 16. It is not known whether these rock exposures are bedrock outcrops or large boulders embedded in the slope.

c. Appurtenant Structures

Spillway

The spillway is cut through the right abutment of the dam. The floor of the spillway channel is bare soil with no lining to protect against erosion; however, the soil in the floor of the channel does not appear to be highly susceptible to erosion and no signs of erosion were evident. There is a 2 foot high concrete weir at the spillway crest, as shown in photograph 2. The spillway training walls are constructed of mortared stone masonry blocks and are in good condition.

The spillway approach channel is shown in photograph 3. The banks of the approach channel are lined with a smooth hand-fitted riprap facing which is in good condition. The spillway discharge channel is shown in photograph 1. Heavily jointed bedrock is exposed in the banks and floor of the discharge channel. There is some brush and a few small trees growing in the

approach and discharge channels, as shown in photograph 1. The concrete and steel beam access road bridge which passes over the spillway was observed to be in good condition.

Outlet Works

A brick gatehouse, shown in photograph 15, is located about 300 feet from the left abutment. A water treatment building is located at the downstream toe of the dam directly downstream from the gatehouse, as shown in photographs 7 and 12. A 30-inch waste drain pipe discharges into a stone masonry-lined outlet channel just to the left of the brick water treatment building at the downstream toe of the dam, as shown in photographs 9, 10, and 11. It is not known if the 30-inch pipe and valve are usable. A 24-inch water supply pipe is used daily with the control valve left open. The condition of this valve is not known. A few dead trees have fallen across the channel, as shown in photograph 11. The service bridge and gatehouse appear to be in generally good condition.

d. Reservoir Area

There are no indications of instability along the banks of the reservoir in the vicinity of the dam.

3.2 Evaluation

Based on the visual inspection, the dam appears to be in generally good condition and the dikes appear to be in generally fair condition. The inspection disclosed the following items which require attention:

a. The trees growing on the slopes and at the downstream toe of the dam and dikes could cause seepage or erosion problems

if a tree blows over and pulls out its roots or if a tree dies and rotting roots provide pathways for seepage.

b. The crests of the dam and dikes are rutted by vehicular traffic and there is no protective vegetation, gravel or paving to protect the crests against erosion.

c. A large erosion gully has formed on the upstream slope of the east dike at the left abutment.

d. Brush and several small trees are growing in the spillway channel, creating a potential obstruction for the spillway flow.

e. Fallen trees are obstructing the outlet discharge channel.

f. The control valves for the 30-inch waste drain pipe and 24-inch water supply pipe should be inspected and repairs made as necessary to make them useable.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General

The purpose of the dam is for public water supply. The reservoirs are supplied by natural runoff and water pumped from the MDC facilities at Spot Pond Reservoir through a 12 inch force main into the Middle Reservoir.

Flow into the Winchester water supply system is controlled by a manually operated gate in the gatehouse which is always kept open. Although not normally used, stoplogs and flashboards can be installed at the spillway to regulate the outflow and reservoir level.

Flow between the Middle and South Reservoir is regulated by a valve and stoplogs at the two culverts between the reservoirs. The stoplogs are manually installed at the intake or gaging structure of the 36 inch culvert. Flow from Spot Pond pumped into Middle Reservoir could reach 300 to 400 million gallons per year. The water level of South and Middle reservoirs normally varies between elevations 155 to 157±.

b. Description of Warning Systems

There are no warning systems in effect at this dam.

4.2 Maintenance Procedures

a. General

The Winchester Department of Public Works is responsible for the maintenance of this dam. The dam and its associated

structures are checked by employees of the Winchester Department of Public Works.

b. Operating Facilities

There is no formal maintenance procedure for this facility. As the dam is used for water supply purposes, any deficiencies in the operational facilities could be detected during normal operation.

4.3 Evaluation

There are no formal written operational or maintenance procedures. The Winchester Department of Public Works periodically checks the facility and performs general maintenance. A program of annual technical inspection should be instituted.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

The South and Middle Reservoirs are located in the northwest section of Medford near the Medford-Stoneham-Winchester corporate boundaries. Their combined drainage area of 0.76 square miles (486 acres) is generally forested and undeveloped. It is made up of hilly terrain which drains directly to the reservoirs. The surface area of the South Reservoir is 100 acres at the top of dam, elevation 163.5, while that of the Middle Reservoir is 71 acres at the top of dam. The reservoirs are separated by an access road dike and natural ground which connects the shore line to a small hill near the middle of the reservoirs.

The dam and its outlets are located at the southern end of the South Reservoir. Water from the spillway and waste pipe is discharged to a small brook which flows southerly along South Border Road towards Medford Square, where substantial residential development occurs.

An earth embankment dike is located across a low area about 1,300 feet to the northeast of the main dam. This East Dike has a length of about 100 feet and a crest elevation of approximately 163.5. A swampy area, due to the topography, is located just below the dike, and a small stream flows from the swamp to the south and then southeast towards Route 93 and South Border Road. A number of homes are located along the road in this area.

Approximately 300 feet to the west of the main dam and about

200 feet from South Border Road is the West Dike. The West Dike is an earth embankment dike having a height of about 6 feet and a length of about 200 feet. The top of this dike is about 3 feet above the pavement elevation of South Border Road. The drainage path beyond the West Dike follows along low ground to the southwest towards the residential areas of West Medford.

A map of the drainage area along with plans and sketches of the structure and its outlets is contained in Appendixes B and D. Additional information on the drainage area and reservoir can be found in Sections 1.2 and 1.3. Photographs of the facilities are shown in Appendix C.

5.2 Design Data

Hydraulic/hydrologic design data for this project could not be located.

5.3 Experience Data

Records of past flood experiences and possible overtopping of the dam could not be located. During the period from August 17 to 20, 1955, U.S. Weather Bureau records indicate about 14 inches of rainfall occurred near the general location of South Reservoir. Similar data from the Weather Bureau shows almost 6 inches of rainfall fell from September 17 to 23, 1938.

5.4 Test Flood Analysis

The dam has an intermediate size classification and a high hazard potential. Based upon Corps Guidelines, the test flood would be the PMF. The test flood inflow from the 0.76 s.m. drainage area was determined to be 2,280 cfs. Runoff from the small 0.76 s.m. drainage area is below the 2.0 s.m. lower limit of the Corps Guideline Chart for Runoff. For these small areas,

test flood runoff rates are based upon 3000 cfs per square mile.

Under normal operation, with no flashboards in place, the 30-inch waste drain gate closed, and the initial pool elevation at 158.5, spillway crest, the test flood would surcharge the reservoirs to elevation 162.3, about 1.2 feet below the top of dam. The routed test flood outflow is 200 cfs through the spillway. The reservoirs would provide stage storage for approximately 17.4 inches of runoff. The test flood would not overtop the natural land between the two reservoirs, the access road dike, or either of the west and east dikes.

If 6 inch flashboards were used on top of the concrete weir (elevation 161, top of flashboard) at the spillway, the routed test flood outflow would be 190± cfs, at elevation 162.7±. The crest of dam (elevation 163.5) would not be overtopped.

5.5 Dam Failure Analysis

South Reservoir has a main dam and two dikes. The west dike is located approximately 300 feet to the west of the main dam; the east dike about 1,300 feet to the northeast. A failure analysis was performed for the main dam and both dikes, assuming an initial reservoir elevation of 163.5, top of dam. Each failure will be discussed separately. See the dam and dikes failure impact maps shown in Appendix D.

No failure analysis was performed for the access road dike. Under normal operating conditions, the maximum pool level difference between the two reservoirs would be no more than 1

foot. The sudden drawdown of the South Reservoir, as a result of the failure of the main dam for example, could cause the subsequent failure of the access road dike. This secondary flood wave could result in additional flood damages within the main dam failure impact area.

Main Dam

The main dam has a hydraulic height of 38 feet and a maximum storage capacity of 1,500 acre-feet. Immediately prior to dam failure, the spillway (assuming the waste pipe closed) would be discharging approximately 450 cfs. If the gate to waste pipe were open, the combined pre-failure discharge would be approximately 540 cfs. These flows, with flood stages of about 1 to 2 feet, would result in little or no flood damages to structures downstream.

Based on Corps "rule of thumb" guidance, failure of the dam would result in a calculated peak outflow of 41,400 cfs. This flow was developed by assuming 40 percent of a 260 foot length of dam, measured at midheight at the original stream location, has failed. It also includes the spillway base flow of about 480 cfs. As the area immediately downstream of the dam is undeveloped, no homes would be inundated by failure flooding within the first 3,300 feet downstream, although portions of South Border Road could be flooded by up to 10 feet of water. In the area between 3,300 and 6,000 feet downstream, at least 10 homes could be damaged from flood stages of 1 to 6 feet in depth, including base flow depths of about 1 foot deep. Downstream of this point, an area of moderate to heavy urban residential

development occurs. A high number of homes, estimated to be in excess of 150 structures, could be inundated by 1 to 10 feet of water. Loss of more than a few lives and excesive property damage could occur as a result of the failure of this dam, therefore, a high hazard classification is established.

West Dike

The west dike has a structural height of 6 feet. However, the South Border Road embankment cuts across the outlet brook about 200 feet beyond the dike. This embankment, which is about 3 feet below the top of the dike, would act as a secondary dam and reduce the extent of the failure of the dike and the resulting failure outflow.

Based on Corps "rule of thumb" guidance and a hydraulic height of 3 feet (for that portion of the dike above the roadway), the peak outflow from failure of the west dike was determined to be 700 cfs. South Border Road would be overtopped by about 3 feet, but there would be no damage for 3,000 feet downstream, as the failure discharge flows through the Middlesex Fells Reservation. Beyond, about 3,900 feet downstream of the west dike, an estimated 5 to 10 homes and several roads would be inundated by 2 to 3 feet of water. Loss of more than a few lives due to failure flooding is possible; thus the West Dike is classified as high hazard.

East Dike

The east dike is approximately 100 feet long and has a hydraulic height of 13.5 feet. Failure of this dike would result in a flood outflow of 3,330 cfs, based on Corps "rule of thumb"

guidance. There is no development within the impact area of the east dike for a substantial distance downstream, (between 5,000 and 5,500 feet). The failure outflow would overtop South Border Road near Bellevue Pond, and could flood several houses by 1 to 3 feet. After crossing South Border Road, the flood water would fill a depression located about 300 feet to the west of Roosevelt Circle. About five houses would be inundated by 5 feet or more.

In addition, the impact area would extend to the Roosevelt Circle Interchange area and Route 93, where another 5 to 10 homes and portions of the interchange, could be flooded by 1 to 2 feet of water. Loss of more than a few lives due to failure flooding is possible; therefore, the East Dike is classified as high hazard.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection did not disclose any immediate stability problems.

6.2 Design and Construction Data

No original design and construction data are available for the dam.

6.3 Post-Construction Data

No information is available about post-construction changes.

6.4 Seismic Stability

The dam is located in Seismic Zone 3 and considering its height, a seismic stability investigation should be conducted as recommended in Section 7.

SECTION 7

ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Based on a visual inspection, the dam is judged to be in generally good condition and the dikes are judged to be in generally fair condition.

b. Adequacy of Information

The information made available, along with the visual inspection, is adequate for a Phase I level investigation.

c. Urgency

The recommendations and remedial measures presented below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.

7.2 Recommendations

The Owners should engage a qualified registered professional engineer to:

a. Determine procedures for removal of trees growing on the dam and dike embankments and to assist in the selection of suitable fill materials for backfilling of the voids left in the embankment after removal of the tree root systems.

b. Perform a seismic investigation of the dam and dikes.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

1. Brush should be cleared from the slopes of the dam and dike embankments and from the area within 10 feet of the downstream toe.

2. The vehicle ruts on the crest of the dam and dikes should be repaired, and the bare soil on the crest should be protected against erosion by a cover of protective vegetation, gravel surface or pavement. Erosion gullies located near the service bridge to the gatehouse should be repaired.

3. The erosion gully on the upstream slope of the east dike at the left abutment should be repaired, and provisions should be made to channel the local runoff at the left abutment so as to prevent future erosion.

4. The brush should be removed from the spillway channel.

5. The fallen trees should be removed from the outlet discharge channel.

6. The Owner should develop a formal warning system for downstream areas in case of an emergency.

7. The Owner should inspect both the 30 inch diameter waste pipe and 24 inch diameter water supply pipe and their valves and make any necessary repairs to insure they can function properly. The waste pipe outlet channel should be cleaned and kept operable.

8. Animal holes should be filled as they appear.

9. The Owner should develop a formal maintenance procedure for the dam and dikes.

10. The owner should institute a program of annual technical inspection.

7.4 Alternatives

There are no practical alternatives for these recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT SOUTH RESERVOIR DAM

DATE Nov. 1, 1979

TIME 7:45 am

WEATHER Cool (~45°), clear

W.S. ELEV. 152+ U.S. ____ DN.S.

PARTY:

1. R. Cheney, HHB
2. D. Vine, HHB
3. D. LaGatta, GEI
4. D. Shields, GEI
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	East Dike	D LAGATTA, D SHIELDS	
2.	West Dike	" "	
3.	Dam Embankment	" "	
4.	Intake Structure	ALL	
5.	Outlet Structure & Channel	ALL	
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Earth Embankment Dam NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney
Structural Engineer

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	163.5
Current Pool Elevation	152±
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed.
Pavement Condition	No pavement, dirt roadway.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	No misalignment observed.
Horizontal Alignment	No misalignment observed.
Condition at Abutment and at Concrete Structures	Minor erosion gullies at sides of service bridge to gatehouse.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	No evidence of trespassing.
Sloughing or Erosion of Slopes or Abutments	Few minor erosion scarps and gullies (up to 2-3 ft wide and 6-12 in. deep) on the lower downstream slope.
Rock Slope Protection - Riprap Failures	Riprap in good condition.
Unusual Movement or Cracking at or Near Toe	None observed.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None.
Vegetation	Brush and several small trees on slopes.

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE East Dike NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney
Structural Engineer

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	EAST DIKE
Crest Elevation	163.5 ±
Current Pool Elevation	152 ±
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed.
Pavement Condition	No pavement, dirt roadway.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	No misalignment observed.
Horizontal Alignment	No misalignment observed.
Condition at Abutment and at Concrete Structures	Erosion on upstream slope at left abutment.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	No evidence observed.
Sloughing or Erosion of Slopes or Abutments	Large erosion gully (4 ft wide and 2.5 ft deep) on upstream slope at the left abutment.
Rock Slope Protection - Riprap Failures	Riprap in reasonably good condition, some minor sloughing.
Unusual Movement or Cracking at or Near Toes	None observed.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None.
Vegetation	Brush and several small trees on slopes and at downstream toe.

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE West Dike NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney
Structural Engineer

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	WEST DIKE
Crest Elevation	163.5 ±
Current Pool Elevation	152 ±
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed.
Pavement Condition	No pavement, dirt roadway.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	No misalignment observed.
Horizontal Alignment	No misalignment observed.
Condition at Abutment and at Concrete Structures	None observed.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	No evid[illegible]served.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection - Riprap Failures	No riprap.
Unusual Movement or Cracking at or Near Toes	None observed.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None.
Vegetation	Trees growing along crest, downstream slope and toe area.

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Intake Structure NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME P. Cheney

Structural Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Not visible, intake under water.
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	Granite Block and Brick Gatehouse was in good condition on the outside. Building was locked during inspection. Inside was not inspected.
Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Control Tower NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney
Structural Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	NONE
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	All gates are manually operated. The operating condition of these valves is unknown. They were not operated during the inspection.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Transition & Conduit NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney
Structural Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	NONE
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Outlet Structure & Channel NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Chenev
Structural Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Granite Block outlet pipe headwall is in good condition, outlet pipe is almost completely silted in.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	None.
Channel	Lined with unmortared stone masonry blocks (floor not visible below water).
Loose Rock or Trees Overhanging Channel	Several small trees overhanging channel, few dead trees fallen across channel.
Condition of Discharge Channel	Silted in and partially blocked by debris.

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Spillway NAME D. LaCatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney
Structural Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Not significant.
Floor of Approach Channel	Floor unlined. Minor brush and few small trees growing in channel.
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None observed
Spalling	None observed.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	None observed.
Drain Holes	None.
c. Discharge Channel	
General Condition	Fair.
Loose Rock Overhanging Channel	Not significant.
Trees Overhanging Channel	Not significant.
Floor of Channel	Floor unlined. Brush and small trees growing in channel.
Other Obstructions	None.

PERIODIC INSPECTION CHECKLIST

PROJECT SOUTH RESERVOIR DAM DATE Nov. 1, 1979

PROJECT FEATURE Service Bridge NAME D. LaGatta

DISCIPLINE Geotechnical Engineer NAME R. Cheney

Structural Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	The painted steel truss and wood desk service bridge was observed to be in good condition.
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

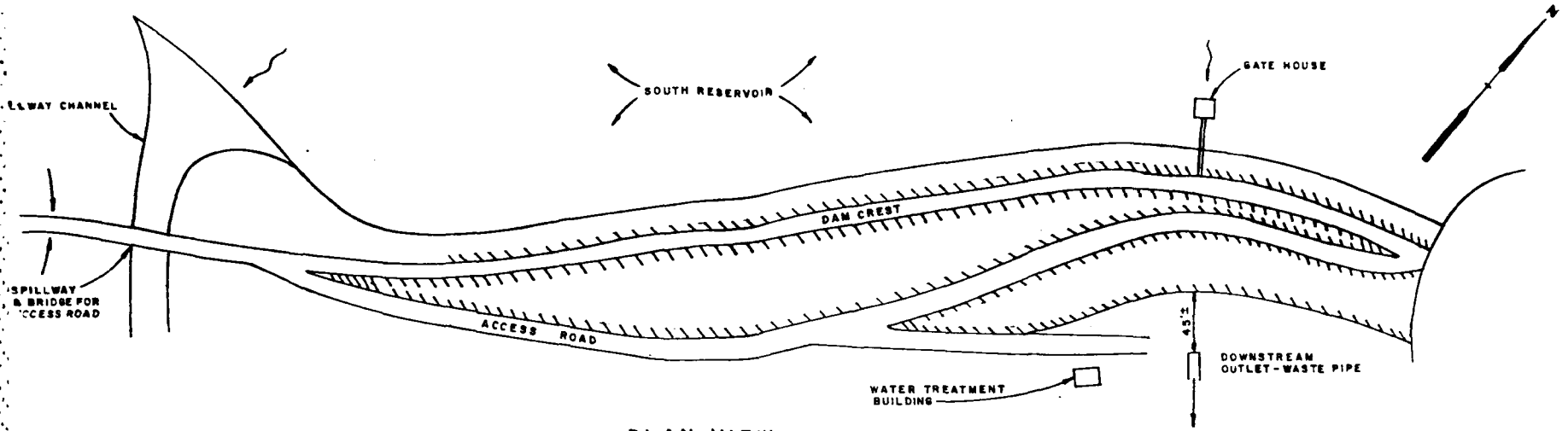
APPENDIX B

ENGINEERING DATA

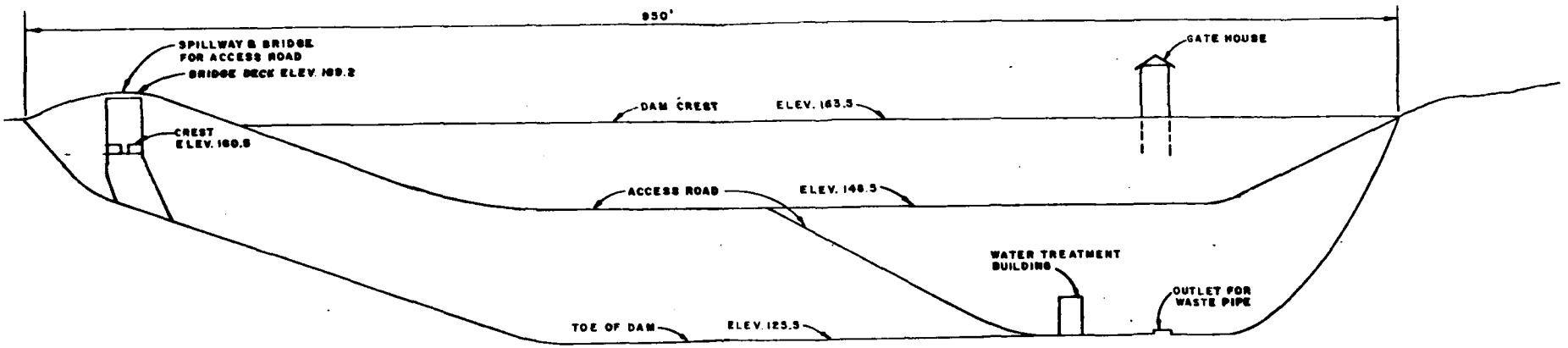
LIST OF ENGINEERING DATA

A State Inspection Report for March, 1974, is available from the Department of Environmental Quality, Waterways Division, 100 Nashua Street, Boston, Massachusetts.

No additional engineering data was located.



PLAN VIEW



ELEVATION

NOTE:
PLAN DEVELOPED FROM ON-SITE INVESTIGATION

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

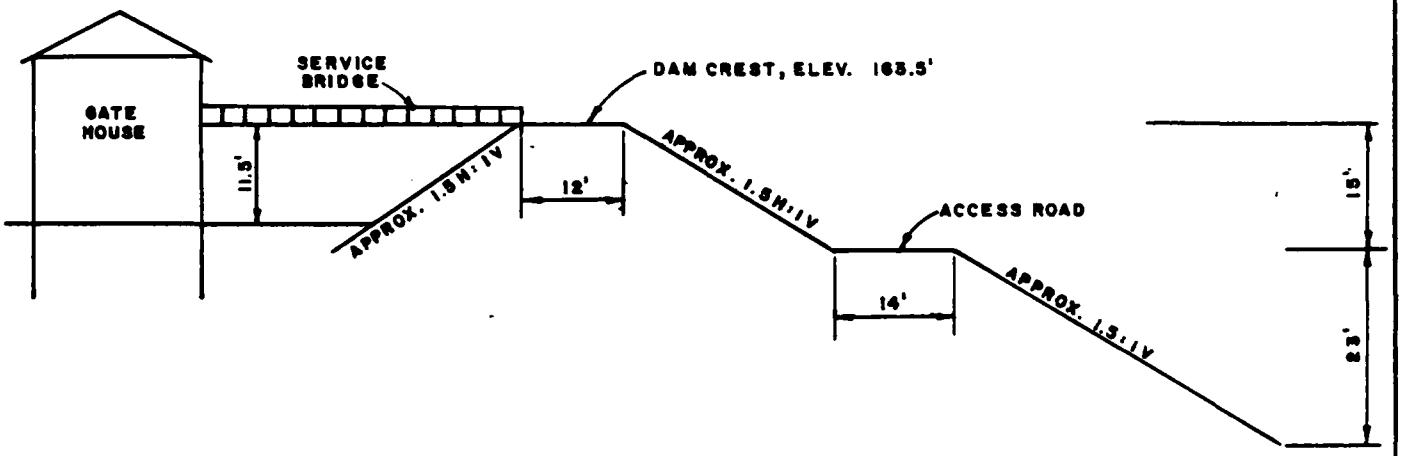
SOUTH RESERVOIR DAM

PLAN & ELEVATION

WINCHESTER MASSACHUSETTS

SCALE NOT TO SCALE

DATE MARCH 1980



SOUTH RESERVOIR DAM
SECTION

NOTE:
PLAN DEVELOPED FROM ON-SITE INVESTIGATION

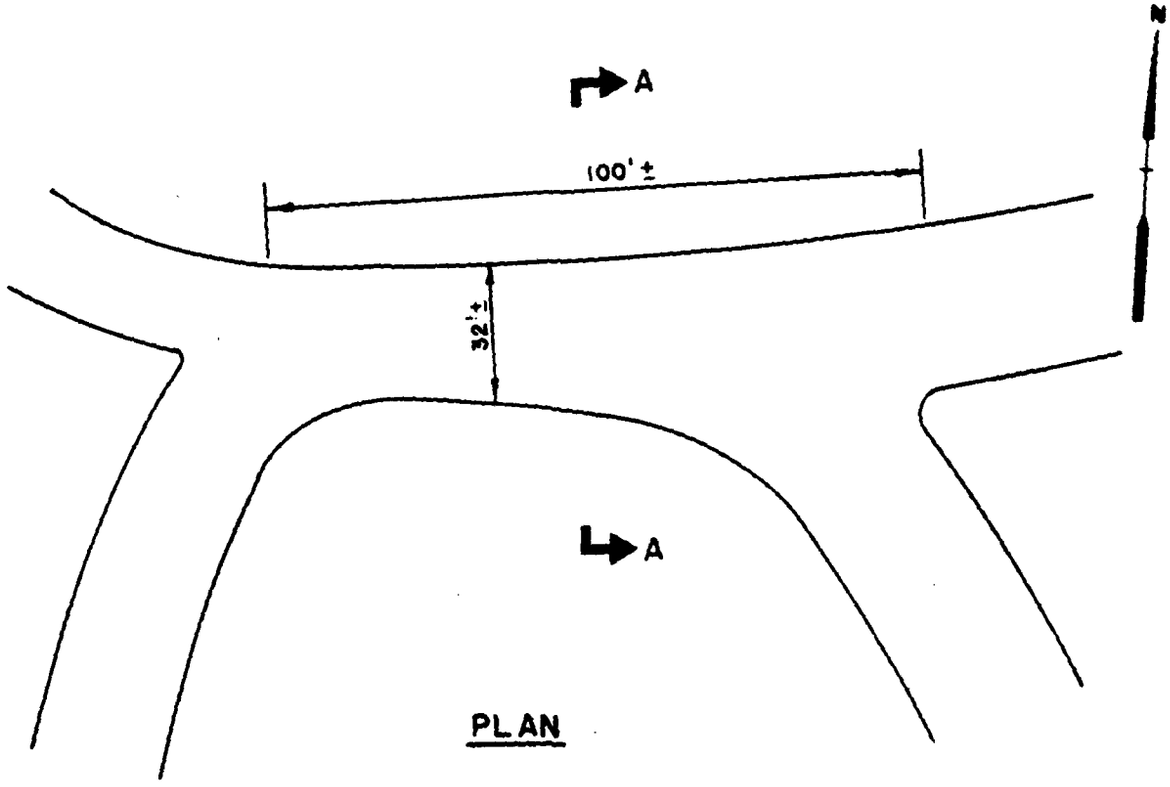
HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

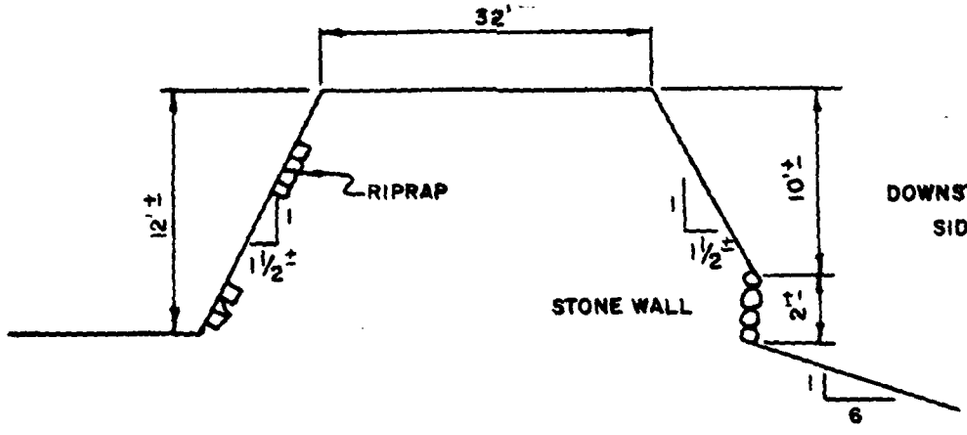
SOUTH RESERVOIR DAM
SECTION

WINCHESTER MASSACHUSETTS

			SCALE: NOT TO SCALE
			DATE: MARCH 1980



PLAN



SECTION A-A

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

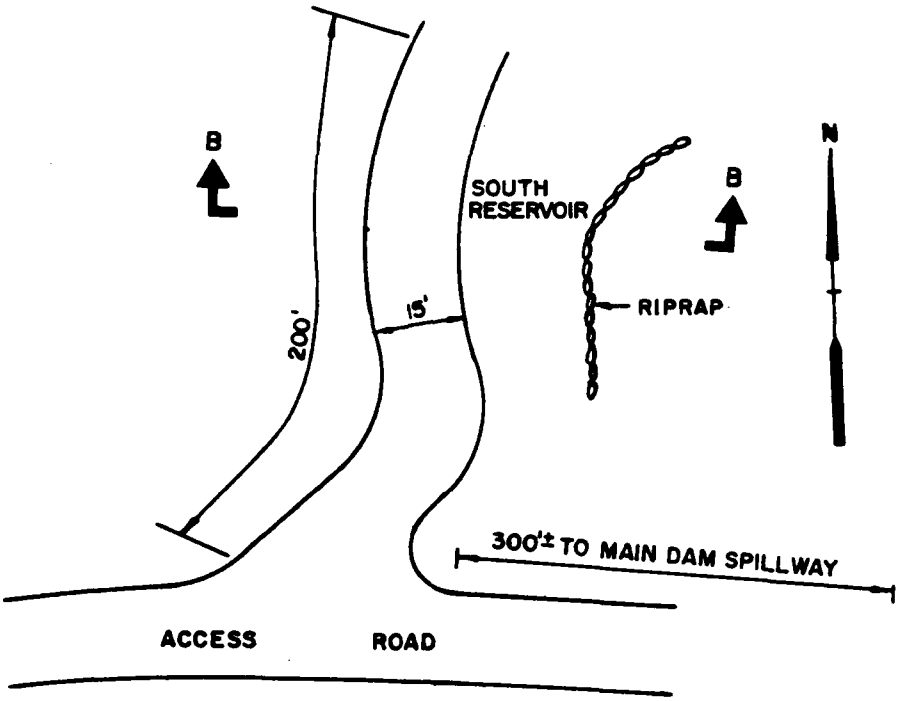
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SOUTH RESERVOIR DAM

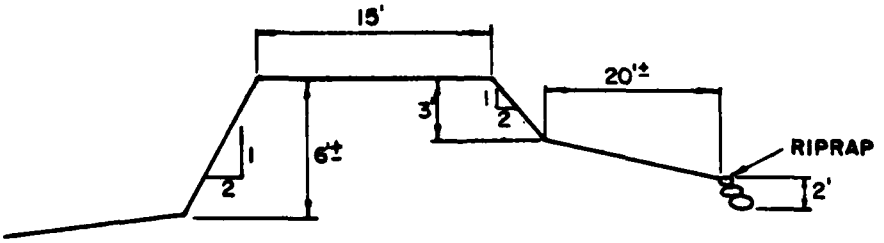
EAST DIKE PLAN & SECTION

MASSACHUSETTS

			SCALE: NOT TO SCALE
			DATE: MARCH 1980



WEST DIKE



SECTION B-B

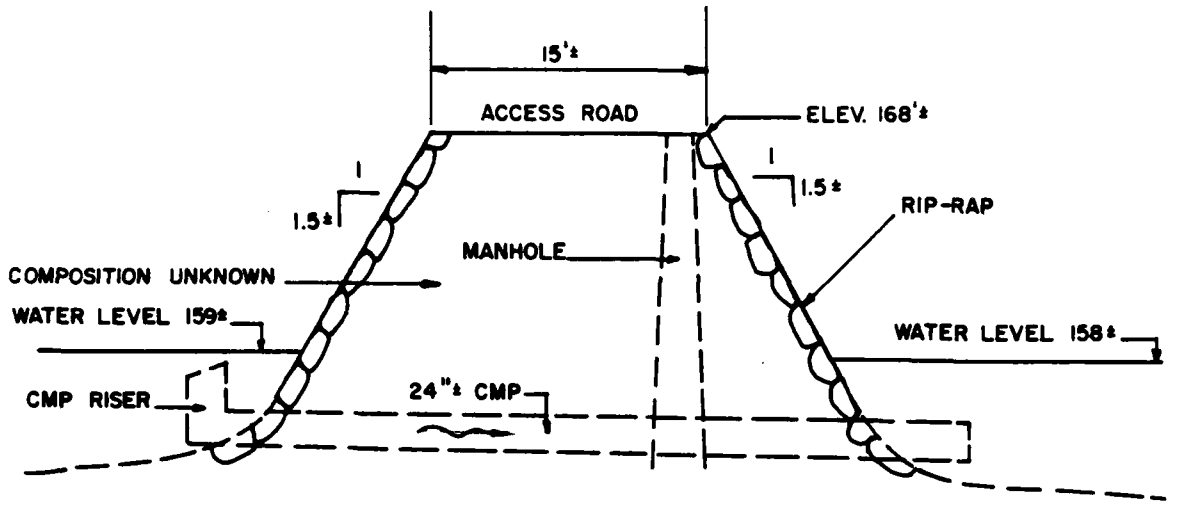
HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

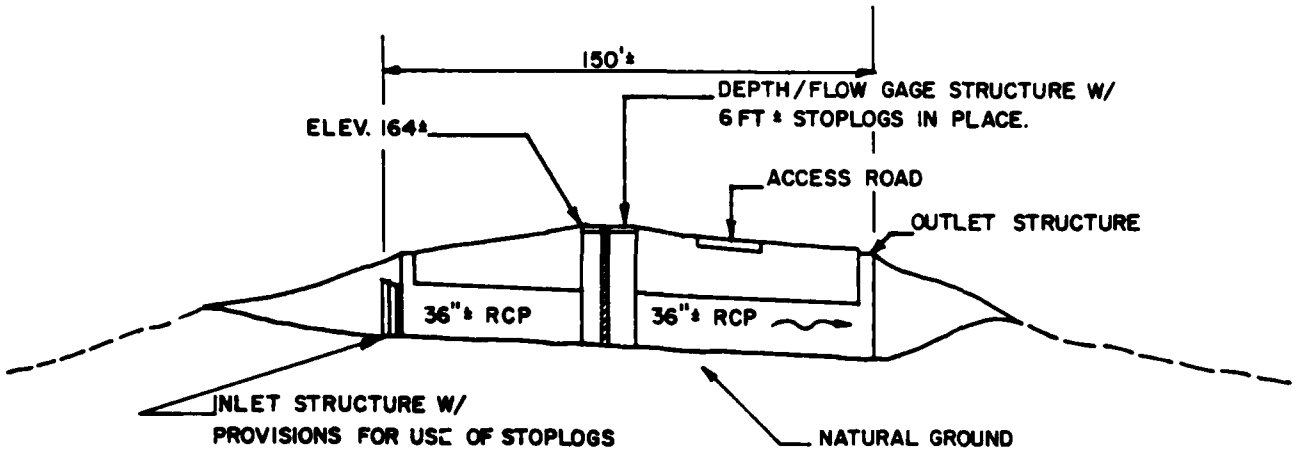
SOUTH RESERVOIR DAM
WEST DIKE PLAN & SECTION

WINCHESTER MASSACHUSETTS

			SCALE: NOT TO SCALE
			DATE MARCH 1980



SECTION AT ACCESS ROAD DIKE
SHOWING CROSS-CULVERT



SECTION AT ACCESS ROAD NATURAL AREA
SHOWING CROSS CULVERT

PLAN DEVELOPED FROM ON-SITE INSPECTION

HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SOUTH RESERVOIR DAM

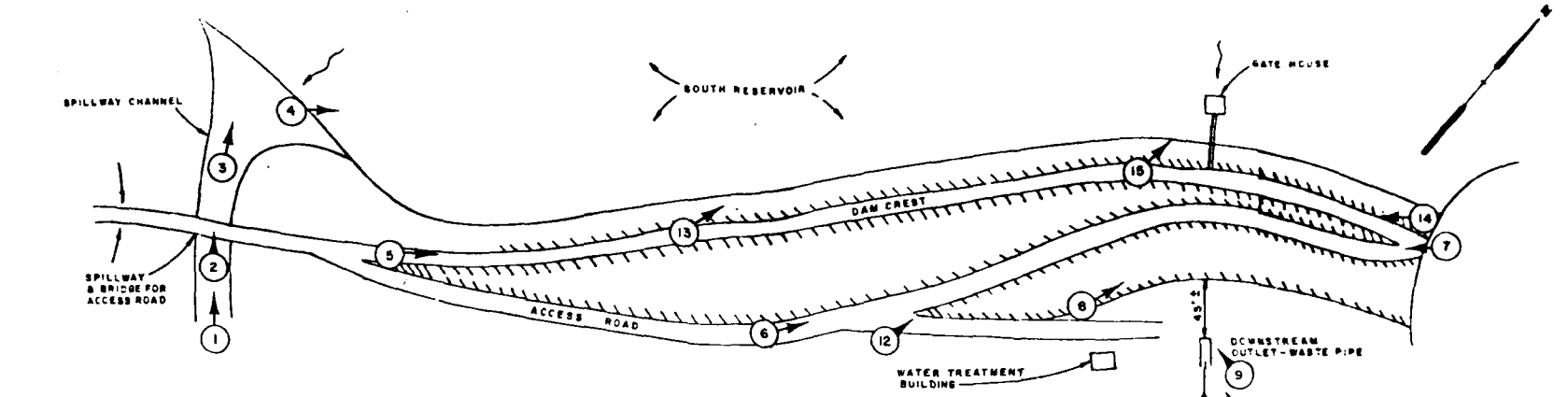
SECTIONS AT ACCESS ROAD DIKE

WINCHESTER MASSACHUSETTS

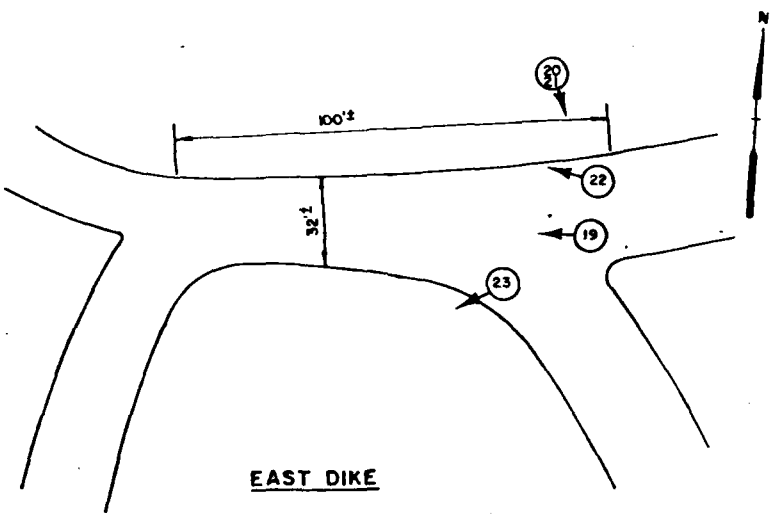
			SCALE: NOT TO SCALE
			DATE: MARCH 1980

APPENDIX C

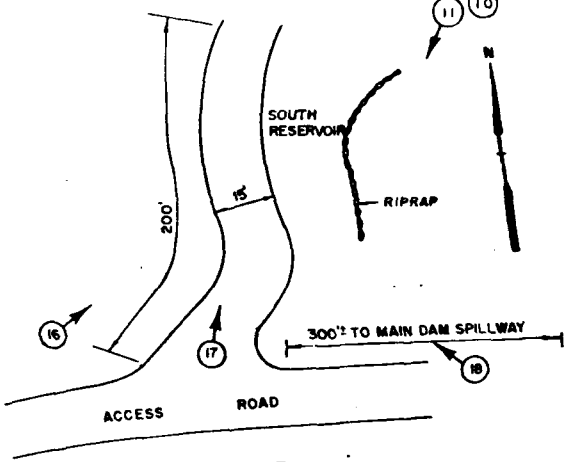
PHOTOGRAPHS



MAIN DAM



EAST DIKE



WEST DIKE

NOTE:
PLAN DEVELOPED FROM ON-SITE INVESTIGATION

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

SOUTH RESERVOIR DAM
PHOTO LOCATIONS

WINCHESTER MASSACHUSETTS

SCALE NOT TO SCALE
DATE MARCH 1980

C-2

PHOTO NO. 3 - Spillway approach channel looking upstream. The channel is about 55 feet long with a gravel base and riprap protection on its sides.

PHOTO NO. 4 - Upstream face of Dam viewed from the spillway approach channel. Gatehouse can be seen in left center of photo. The crest of the Dam is used as an access road for gatehouse. Note riprap protection along face of Dam.

PHOTO NO. 1 - Spillway discharge channel, and access road overpass, looking upstream.

PHOTO NO. 2 - Spillway weir looking upstream.

PHOTO NO. 5 - Crest of Dam, viewed from right abutment.

PHOTO NO. 6 - Upper portion of the downstream slope of the Dam, looking left along the midslope berm.

PHOTO NO. 7 - Lower portion of the downstream slope, viewed from the left abutment of the Dam. Note water treatment building in middle left portion of photo.

PHOTO NO. 8 - Lower portion of the downstream slope, looking left and slightly upstream from the downstream toe.

PHOTO NO. 9 - Outlet pipe located about 40-50 feet from the downstream toe. Outlet pipe (30 inch dia.) is almost completely submerged at head of channel. Function of the small drain pipe (5 inch dia.) that protrudes above the channel is not known. (Scale is open to 1 foot in the photo.)

PHOTO NO. 10 - Outlet channel, looki upstream. The water level in t channel is approximately 12 inc deep. The outlet pipe at the h of the channel is almost comple submerged.

PHOTO NO. 11 - Outlet channel, looking downstream.

PHOTO NO. 12 - Downstream slope, looking left. Note the configuration of the midslope berm separating the upper and lower portions of the downstream slope.

PHOTO NO. 13 - Reservoir viewed from Dam crest. Gatehouse can be seen in right center of photo. Tree cover around reservoir is typical of drainage area.

PHOTO NO. 14 - Upper portion of the downstream slope, viewed from the left abutment of the Dam.

PHOTO NO. 15 - View of the gatehouse. The gate house contains manually operated controls to allow the reservoir to discharge into either a 30 inch waste pipe or a 24 inch pipe on the town water supply system.

PHOTO NO. 16 - This view shows the west dike. The access road is on top of the 6 foot high dike.

PHOTO NO. 17 - View of crest of west dike taken from left abutment.

PHOTO NO. 18 - Upstream slope of the West Dike, viewed from a point upstream of the left abutment.

PHOTO NO. 19 - Crest of the east dike, viewed from the left abutment.

PHOTO NO. 20 - View of the erosion gully on the upstream slope of the east dike at the left abutment. The gully is approximately 4 feet wide and 2.5 feet deep. (Rule is open to 4 feet in the photo.)

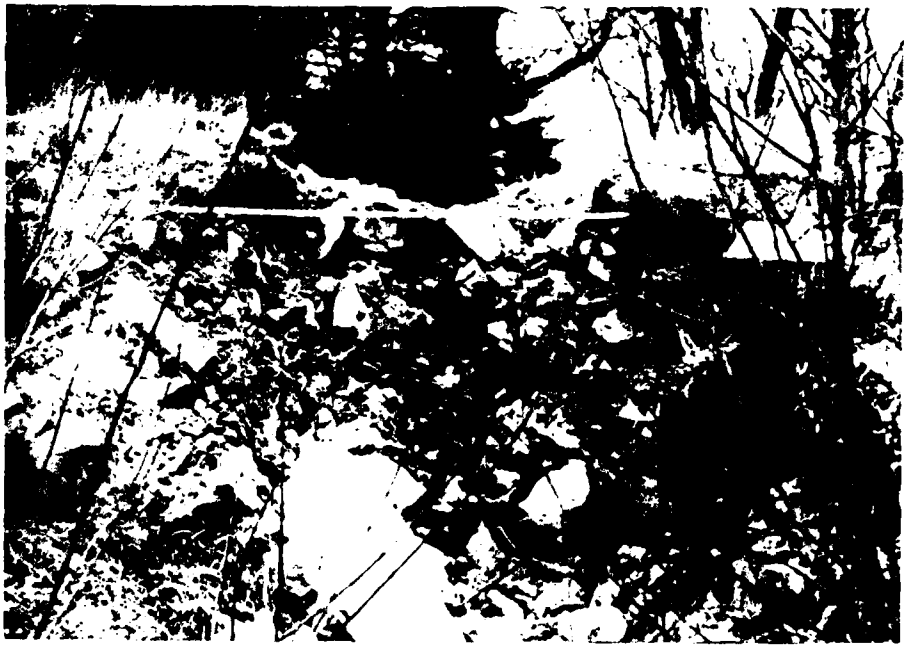


PHOTO NO. 21 - Close up view of Photo No. 20.

PHOTO NO. 22 - Upstream slope of the east dike, viewed from the left abutment.

PHOTO NO. 23 - Downstream slope of the east dike, viewed from the left abutment. The rubble stone wall at the toe of the slope is approximately 2-3 feet high.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

JOB NO. 79.206.1
DATE 12/20/79
BY FDD
CH'D BY MA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D2
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

South Reservoir Dam : Built 1870's ±

Height of Dam: 38.0'

Outlets: 24" pipe - Town water supply

30" pipe - waste to down-stream brook

Spillway & Channel

Earth Embankment Structure with stone core wall, used for water supply purposes. South & Middle Reservoirs separated by natural & man-made embankment

Storage Capacity: 2720.± ac-ft (includes Middle Reservoir)

Size Class : Intermediate (by Storage)

Drainage Area: 0.76 sq. mi (486 acres)

Hazard Potential : High

Test Flood: PMF

Corps Guidelines Require that Runoff from drainage areas of 2 sm or less are developed using 3000. c.s.m.

PMF Inflow = 3000 × .76 × 1 = 2280 cfs

Volume of runoff = 19" × 1/12 × 486 = 770 ± a-f

PMF Outflow = 265 ± cfs. (No stoplogs @ Spillway, waste gate closed)

Dam is not overtopped.

JOB NO. 79.206.1
DATE 11/23/80
BY FDD
CH'D BY MF

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BOSTON — WEST HARTFORD

SHEET NO. D3
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

Storage Capacity - South & Middle Reservoirs

Elev NGVD	South Reservoir Area ac.	Ave Area ac.	D Ft.	Stor ac-ft.	Middle Reservoir Area ac.	Ave Area ac	D Ft	Stor ac-ft	Cum. Storage ac-ft.
130±	0.0				0.0				
		36.7	28	1027.6 ✓		27.2	28	761.6 ✓	1789.2 ✓
158±	73.5				54.4				
		82.3	2	164.6 ✓		59.9	2	119.8 ✓	2073.6 ✓
160	91.0				65.3				
		103.1	10	1031 ✓		73.6	10	736 ✓	3840.6 ✓
170	115.2				81.9				

(Elevations assumed using U.S.G.S. map)

Top of dam elev. ≈ 163.5

JOB NO. 75.206.1
DATE 12/20/75
BY EDD
CH'D BY

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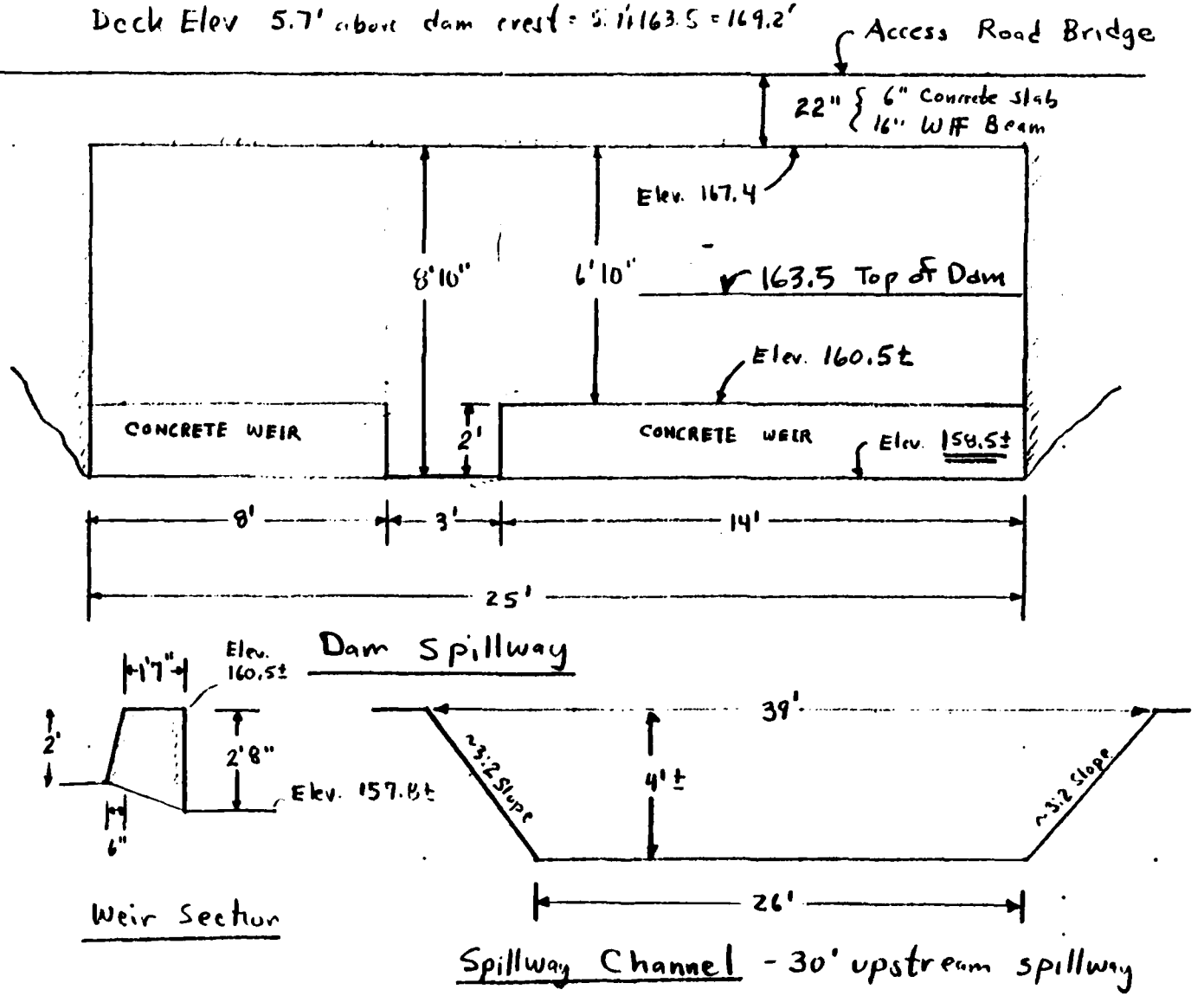
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

JOB Dam
SUBJECT South Reservoir Dam
CLIENT Corps

SHEET NO 4

South Reservoir Dam

Deck Elev 5.7' above dam crest = 5.7+163.5 = 169.2'



Dam Spillway

Weir Section

Spillway Channel - 30' upstream spillway

JOB NO. 79.206.1
DATE 12/20/79
BY FDD
CH'D BY WA

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BOSTON — WEST HARTFORD

SHEET NO. D-5
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

Outlet capacity - South Reservoir

Dam Spillway (not used for discharge graph) - consists of 2' high weir in 2 sections & a 3' wide slotted "channel" also has what are apparently pins for up to 6" flashboards on top of weirs.

Check worst condition: stop logs in channel section & 6" flashboards
Top elev = 161.0 ± $Q = CLH^{3/2}$

Spillway Outflow - Stoplogs & flashboards in place

6" Flashboards in place	H ft	$H^{3/2}$	C	L ft	Q cfs	Elev
	1.0	1.0	2.70	25	67.5	162.0
	2.0	2.83	2.95	"	208.7 ✓	163.0
	3.0	5.20	3.28	"	426.1	164.0
	4.0	8.0	3.32	"	664.0 ✓	165.0
	5.0	11.18	3.32	"	928.0 ✓	166.0
	2.5	3.95	3.20	"	316.0	163.5

Weir - Spillway Outflow - no (additional) controls at spillway (3'x2' opening) actual conditions
Channel Area use $Q = CLH^{3/2}$ with C = 2.63, L = 3

H ft	$H^{3/2}$	CL 3×2.63	Q cfs	Elev
1	1.0	7.89	7.9	159.5 ✓
2	2.83	"	22.3 ✓	160.5 ✓
2.5	3.95	"	31.2	161.0 ✓

JOB NO. 79.206.1
DATE 12/20/79
BY EDD
CH'D BY

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BOSTON — WEST HARTFORD

SHEET NO D-6
JOB Dams
SUBJECT South Res. Dam
CLIENT Corps

Dam Spillway Out Flow - South Reservoir Dam

Weir Sections: $Q = CLH$ $L = 25'$

(used for graph)

	H ft	$H^{3/2}$	C	L ft	Q cfs	Elev.
No flashbrds	1.0	1.0	2.70	25	67.5	161.5
	2.0	2.83	2.95	"	208.7	162.5
	3.0	5.20	3.28	"	426.4	163.5
	4.0	8.0	3.32	"	664.0	164.5
	4.5	9.55	"	"	792	165.0
1ft ↑	5.5	12.9	"	"	1070	166

Check Waste Pipe (Ability to use is unKnown)

30 inch diameter metal pipe (made from boiler flanges)

Out Flow controlled by sluice gate located within gate house - operation unKnown outlet appears blocked.

Discharges to outlet structure & flows to downstream brook

Assume Invert to waste pipe ~ 45' below top of dam, @ elev 120 ±

Estimating the outflow with $h \approx 40'$, $Q = 150$ cfs ±

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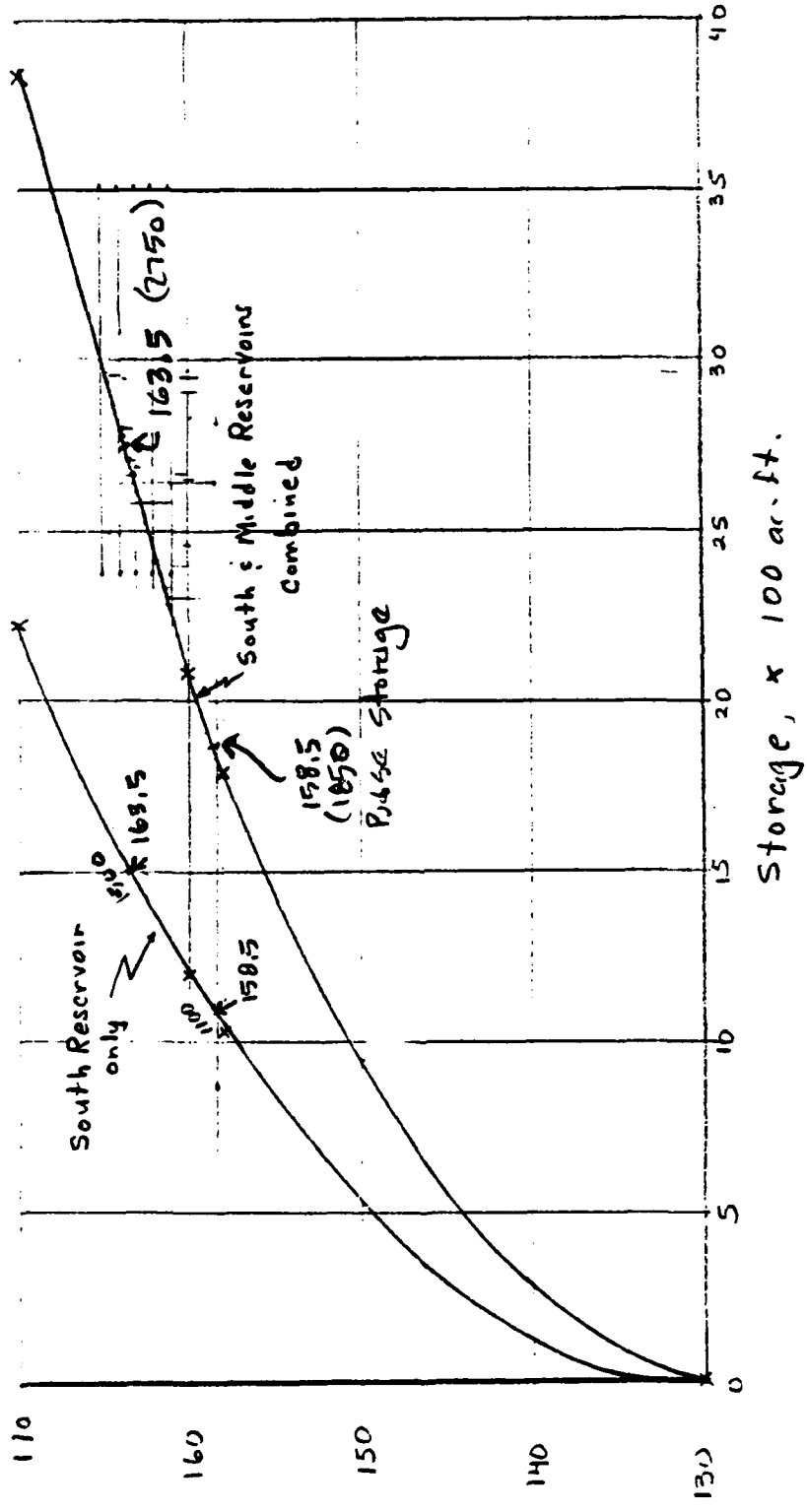
SHEET NO. D7
JOB Dam
SUBJECT [illegible] Dam
CLIENT Corps

Elevation vs. Storage - South & Middle Reservoirs



Above elevation 163.5', get weir flow over a portion of the top of dam.

$Q = CLH^{3/2}$ with $C = 2.63$ & $L = 400$

H ft	$H^{3/2}$	CL 400×2.63	Q cfs.	Elev.
0.5	0.35	1052	372±	164.0
1.0	1.0	1052	1052±	164.5
1.5	1.84	1052	1933±	165.0

OVERFLOW AND SPILLWAY DISCHARGE

ELEV	2'×3' Weir	SPILLWAY NO FLH.	SPILLWAY WITH FLH	OVERFLOW	COMBINED NO FLH	COMBINED WITH FLH
158.5	0	0	0	0	0	0
159.	8	0	0	0	8	8
159.5	—					
160.0	—					
160.5	22				22	22
161.0	(31)					31
161.5		68			90	
162.0			68			99
162.5		209			231	
163.0		316	209		338	240
163.5		426	316		448	347
164.0		540	426	372	934	829
164.5		664	540	1052	1738	1631
165.0		792	664	1933	2747	2628

JOB NO. 79.206.1
DATE 4-20-80
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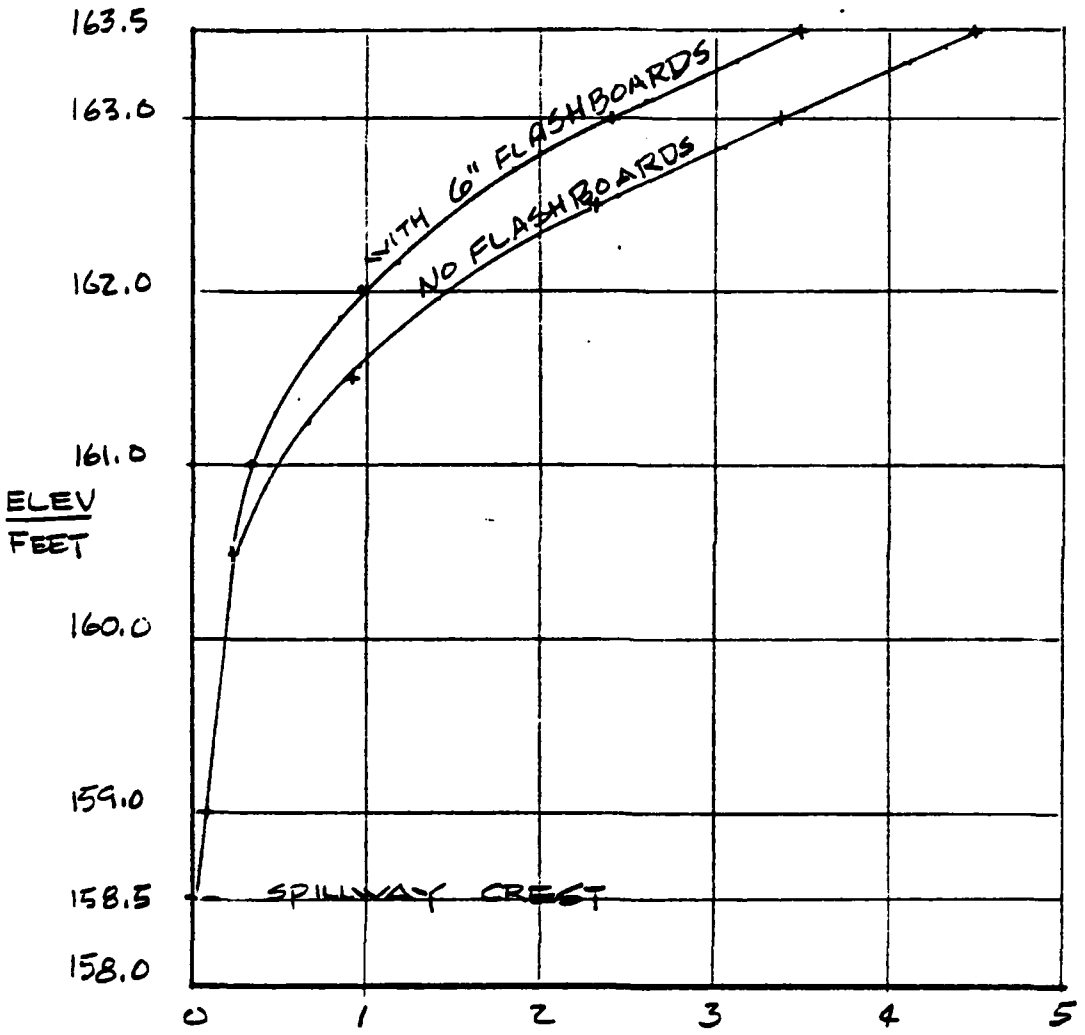
SHEET NO D8A
JOB Ddms
SUBJECT So. Res.
CLIENT COE

STAGE DISCHARGE



COMBINED DISCHARGE, CFS x 100

- Continued on page D8B -

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DATE 4/20/80
BY FDD
CH'D BY WA

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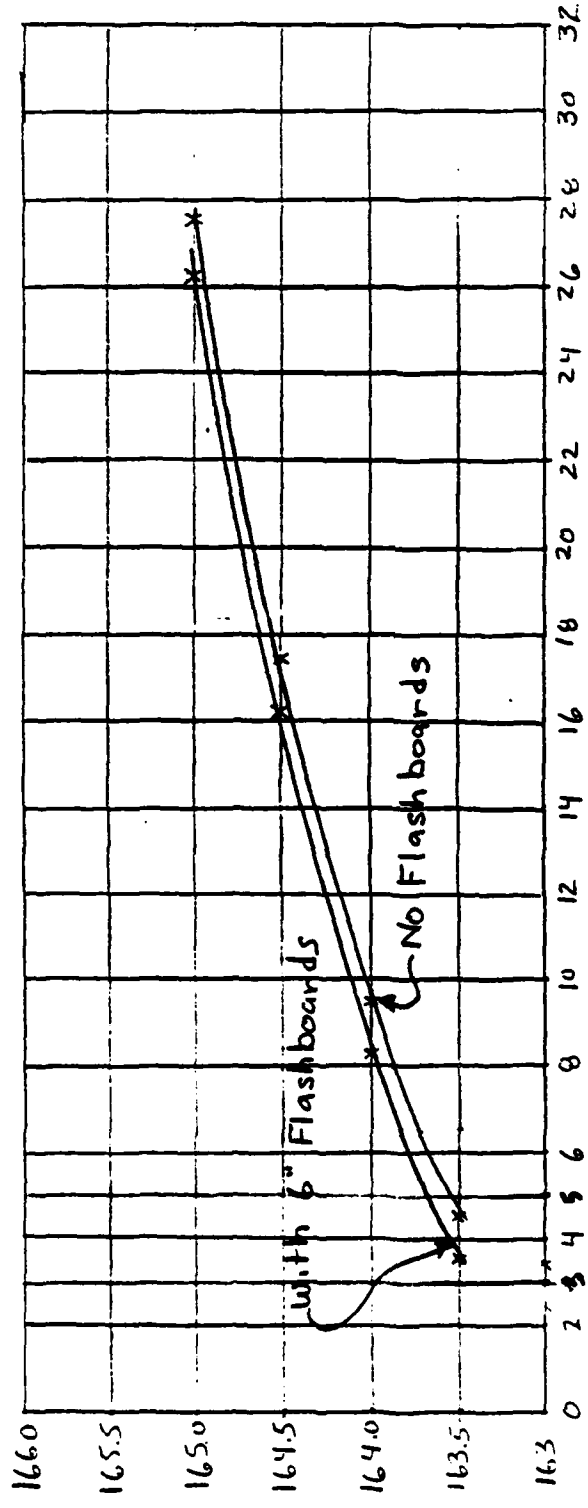
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D & B
JOB Dam:
SUBJECT Sa Res
CLIENT COE

STAGE DISCHARGE



Combined Overflow, cfs x100

- see page D8A -

see PS D8A

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Test Flood - South Reservoir Dam

A = 0.76 sm. (includes areas to both South & Middle Reservoirs)
assume flow between reservoirs ✓

$Q_{PMF} = 3000 \times 0.76 \times 1 = 2280$ cfs.

Volume = $19\text{ in} \times 486\text{ ac} \times \frac{1\text{ ft}}{12\text{ in}} = 770$ ac-ft

Elev of Spillway = 158.5' NGVD
Storage Volume = 900 ac-ft (163.5 to 158.5
(770 af = El 163.0±)

Top of Dam Elev. = 163.5 ±
Top of Natural Dike @ Middle Res. = 164. ±

Storage Volume - Top of Dam = 2756 ac-ft.

Stor. avail. > Stor required for PMF inflow

Determine PMF Outflow: Normal operation with waste gate closed & no stop logs or flashboards @ spillway.

Assume initial reservoir level @ Spillway Invert elev. = 158.5± NGVD

NO FLASHBOARDS AT SPILLWAY

TEST FLOOD ROUTED OUTFLOW

D.A. = 0.76 sm
486 a

Q_{P_1} = 2280 cfs Inflow El_1 = 164.8
Str_1 = 2950 - 1850 = 1100 a-f or 27.2" > 19
Str_{ave} = $\frac{27.2+0}{2}$ = 13.6

Q_{P_3} = 2280 $\left(1-\frac{13.6}{19}\right)$ = 648 cfs El_3 = 163.7
Str_3 = 2800 - 1850 = 950 a-f or 23.4"
Str_{ave} = $\frac{13.6+23.4}{2}$ = 18.5"

Q_{P_4} = 2280 $\left(1-\frac{18.5}{19}\right)$ = 60 cfs El_4 = 161.2
Str_4 = 2740 - 1850 = 490 a-f or 12.1"
Str_{ave} = $\frac{18.5+12.1}{2}$ = 15.3"

Q_{P_5} = 2280 $\left(1-\frac{15.3}{19}\right)$ = 444 cfs El_5 = 163.5
Str_5 = 2700 - 1850 = 850 a-f or 21"
Str_{ave} = $\frac{21+15.3}{2}$ = 18.2"

Q_{P_6} = 2260 $\left(1-\frac{18.2}{19}\right)$ = 96 cfs El_6 = 161.6
Str_6 = 2360 - 1850 = 510 or 12.6"
Str_{ave} = $\frac{12.6+18.2}{2}$ = 15.4

Q_{P_7} = 2280 $\left(1-\frac{15.4}{19}\right)$ = 432 cfs El = 163.4
Str = 2670 - 1850 = 820 a-f or 20.2"
Str_{ave} = $\frac{20.2+15.4}{2}$ = 17.8"

Q_{P_8} = 2280 $\left(1-\frac{17.8}{19}\right)$ = 144 El_8 = 162.0
Str_8 = 2400 - 1850 = 550 or 13.6"
Str_{ave} = $\frac{13.6+17.8}{2}$ = 15.7"

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$Q_{15} = 2280\left(1 - \frac{15.7}{19}\right) = 396 \qquad El_q = 163.3$

$Str_q = 2620 - 1650 = 770 \quad$ on 19"

$Str_{ave} = \frac{19 + 15.7}{2} = 17.4$

$Q_{P,10} = 2280\left(1 - \frac{17.4}{19}\right) = 192 \qquad El_q \cong 162.3$

$Str_{10} = 2550 - 1650 = 700 \quad$ or 17.3

$Str\ ave = \frac{17.3 + 17.4}{2} = 17.35$

$Q_{Y11} = 2280\left(1 - \frac{17.35}{19}\right) = 198 \qquad El_{10} = 162.3$

$Q_{out} = 200^{\pm}\ cfs \qquad Elev = 162.3^{\pm}$

TEST FLOOD ROUTED OUTFLOW
WITH 6" FLASHBOARDS AT SPILLWAY

$Q_{P_1} = 2280$ $El_1 = 164.8$ $Str_1 = 2950 - 1850 = 1100$ 27.2"

$Str_{ave} = \frac{27.2 + 0}{2} = 13.6$ "

$Q_{P_3} = 2280\left(1 - \frac{13.6}{19}\right) = 650.$ cfs $El_3 = 163.7$

$Str_3 = 2775 - 1850 = 925$ or 22.8 "

$Str_{ave} = \frac{22.8 + 13.6}{2} = 18.2$"

$Q_{P_4} = 2280\left(1 - \frac{18.2}{19}\right)^2 = 96.$ cfs $El_4 = 162.0$

$S_4 = 2450 - 1850 = 600 = 14.8$ "

$S_{ave} = \frac{14.8 + 18.2}{2} = 16.5$ "

$Q_{P_5} = 2280\left(1 - \frac{16.5}{19}\right)^2 = 300.$ cfs $El_5 = 163.3$

$S_5 = 2630 - 1850 = 780 = 19.3$ "

$S_a = \frac{16.5 + 18.3}{2} = 17.4$"

$Q_{P_6} = 2280\left(1 - \frac{17.4}{19}\right) = 192$ cfs. $El = 162.8$

$S_6 = 2580 - 1850 = 730 = 18.0$"

$S_a = \frac{17.4 + 18.0}{2} = 17.7$

$Q_{P_7} = 2280\left(1 - \frac{17.7}{19}\right) = 156$ cfs $El = 162.5$

$S_7 = 2530 - 1850 = 680$ ac-ft $= 16.8$ "

$S_{ave} = \frac{17.7 + 16.8}{2} = 17.3$ "

$Q_{P_8} = 2280\left(1 - \frac{17.3}{19}\right) = 204$ cfs $El = 162.8$

$S_8 = 730 = 18.0$ "

$S_a = 17.3 + 18 = 17.65$ "

$Q_{P_9} = 2280\left(1 - \frac{17.65}{19}\right) = 162$ cfs $El = 162.5$

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BOSTON — WEST HARTFORD

Q_{P_9} = 162 cfs. Elev = 162.5

S_9 = 2530 − 1850 = 680 = 16.8"

S_a = $\frac{16.8 + 17.65}{2}$ = 17.23"

$Q_{P_{10}}$ = 2280 $\left(1 - \frac{17.23}{19}\right)$ = 212 cfs Elev. = 162.8

Elev. varies between 162.5 and 162.8

Let Elev = $\frac{162.5 + 162.8}{2}$ = 162.65 ~ 162.7

Q = 190± cfs

Elev = 162.7 Q = 190 cfs.

Failure Outflow - South Reservoir Dam

Breach width = 40% of 260' length of dam measured at midheight, at "original stream" location.

Failure Discharge, $Q_F = \frac{8}{27}(0.4 \times B_w)(\sqrt{g})(H)^{3/2}$

$Q_F = \frac{8}{27}(0.4 \times 260)(\sqrt{32.2})(38.0)^{3/2}$

$Q_F = 40,930^{\pm}$ cfs. ✓

Breach width limited by downstream channel - see Section 6+00

Assume Dam fails with pool at top of dam

Storage at time of failure = S

S = 1500 ac-ft (el=163.5)

Max. Base flow just prior to failure of dam is on the order of 450 cfs ± assuming gate to waste pipe is closed and no additional controls (i.e. stop logs and flashboards) in place at spillway.

Combined Failure Discharge & Base flow =

40,930 + 450 = 41,380 cfs., say 41,400 cfs

$Q_p = 41,400$ cfs.

JOB NO. 79.206.1
DATE 12127179
BY FDD
CHK'D BY MA

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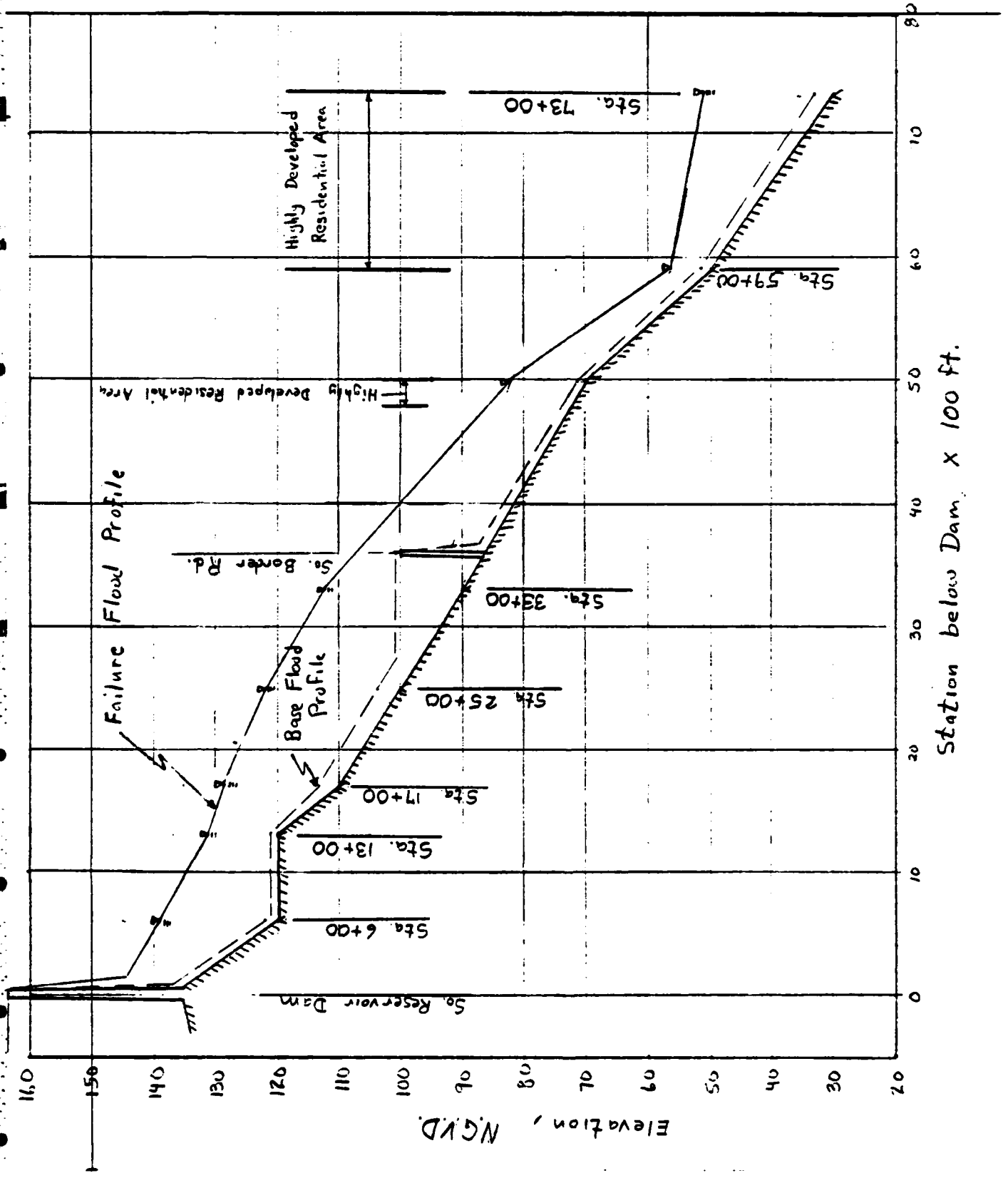
SHEET NO D14
JOB Dams
SUBJECT So. Res. Dam
CLIENT Corps



JOB NO. 792061
DATE 1-15-80
BY MA
CH'D BY FDD

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CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D 15
JOB Dams
SUBJECT So. Res.
CLIENT CE

Std	Elev	Base Flow Elev (500± cfs)	Base Flow Damage	Failure Flow Elev (41000± cfs)	Failure Flow Damage
6+00	120	121	—	139.3	So. Border Rd
13+00	120	121	—	131.1	S.B.R.
17+00	110	111	—	129	S.B.R
25+00	100	101	—	122	SBR
33+00	90	91	—	112	SBR
35+00					Residential 10± homes
50+00	70	71	—	85	
60+00					Residential
59+00	50	51	—	56	
73+00	30	31	—	41	

At least 150 to 250 homes in this area.

JOB NO. 79.206.1
DATE 12/26/79
BY FDD
CHK'D BY WA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D16
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

South Reservoir Dam

Impact Areas - Failure Flood Routing

Sta. 0+00 to 33+00: No homes or other inhabitable structures inundated Approximately 3000 ± of So. Border Rd flooded by 1-10' ± of water

Sta 33+00 to 59+00: Possibly a number of houses by 1-6' of water. Flood limits impact a "pink tint" (on USGS) highly developed area [illegible] Sta 52+00 and along Lawrence Rd near Sta 59+00. Damage would be significant

Sta. 59+00 to 73+00 and beyond: Large number of houses inundated by 1-11' of floodwater in thickly settled (highly developed "pink tint" on USGS) area. Extensive Damages could occur in this area from the failure Flood. 250 ± homes

JOB NO. 79.206.1
DATE 12/21/79
BY FDO
CH'D BY WAF

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CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D 18
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

Dam Failure Flood Routing - So. Res. Dam

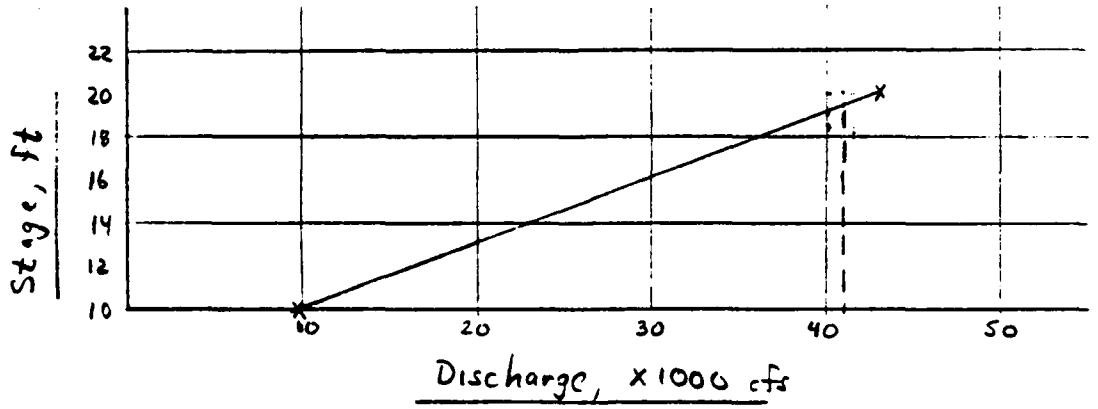
$Q_F = 41,400$ cfs.

Sta. 6+00

$S = 0.05$ $n = 0.12$

$V = f' R^{2/3}$ $V = 2.77 R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev.
10	150	1000	3.56 ✓	2.77	9.87 ✓	9874 ✓	130
20	600	4250	3.71 ✓	"	10.28 ✓	43,705. ✓	140



$Q_{P_1} = 41,400$ cfs $d_1 = 19.6'$ ✓

$Vd_1 = \frac{2785+4004}{2} \times \frac{400}{43560} = 31.17$ ✓ ac-ft

$Q_{P_2} = 41,400\left(1 - \frac{31.17}{1500}\right) = 40,540$ cfs ✓

$d_2 = 19.3'$

AD-A154 734 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
SOUTH RESERVOIR DAM A.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV APR 80

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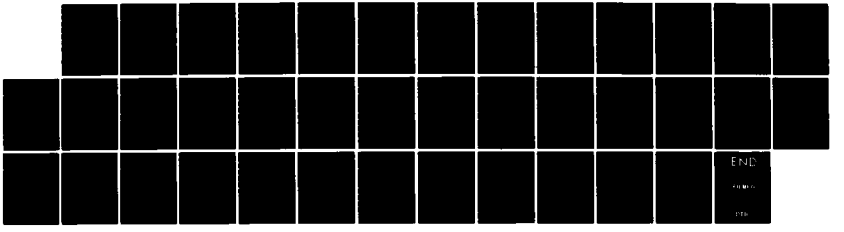

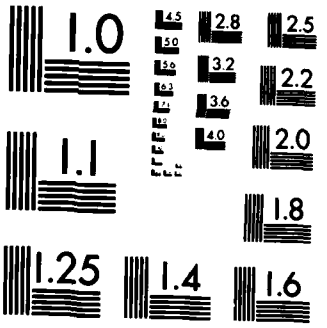

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BOSTON — WEST HARTFORD

SHEET NO. D17
JOB Dams
SUBJECT South Res. Dam
CLIENT Corps

South Reservoir Dam

Check: Impact of Base Flood Flows

Q_{Base} = 450 cfs.

Sta. 0+00 to 59+00 - No effect on man-made structures

Sta. 59+00 - No effect on adjacent developed areas ($Q = 26,942$, $d = 6.1'$; no development below $d = 5\pm$)
for $Q = 450$ cfs. $d \approx 1.0' \pm$ $V \cong 5 \pm$ fps

Sta 73+00 - minor - moderate flooding of adjacent developed areas.

for $Q = 450$ $d \sim 1.0' \pm$ $V \cong 1.5 \pm$ fps

Comparison of Impact Areas: Base Flood & Failure Flood

	Base Flood	Failure Flood
Sta. 0+00 to 59+00	So. Border Rd overtopped by 1'± for 200'±	So. Border Rd overtopped by 5-10' for ~3000' Several houses flooded by 1-5'
Sta. 59+00 to 73+00	Hvy developed residential area flooded by 1-2½ for width up to 250 ft ± Expected damage - minor to moderate	Hvy. developed residential area flooded by 6-11' ± for width up to 1150 ft ± Expected damage - extensive

Failure Flood Routing - So. Res. Dam

$$Vol_2 = \frac{2785 + 3861}{2} \times \frac{400}{43560} = 30.52 \text{ ac-ft} \checkmark$$

$$Q_{P_2} = 41{,}400\left(1 - \frac{30.52}{1500}\right) = 40{,}558 \text{ cfs.} \quad d_2 = 19.3\pm' \checkmark$$

$$Q_{out} = 40{,}558 \text{ cfs} \qquad Elev = 139.3'\pm$$

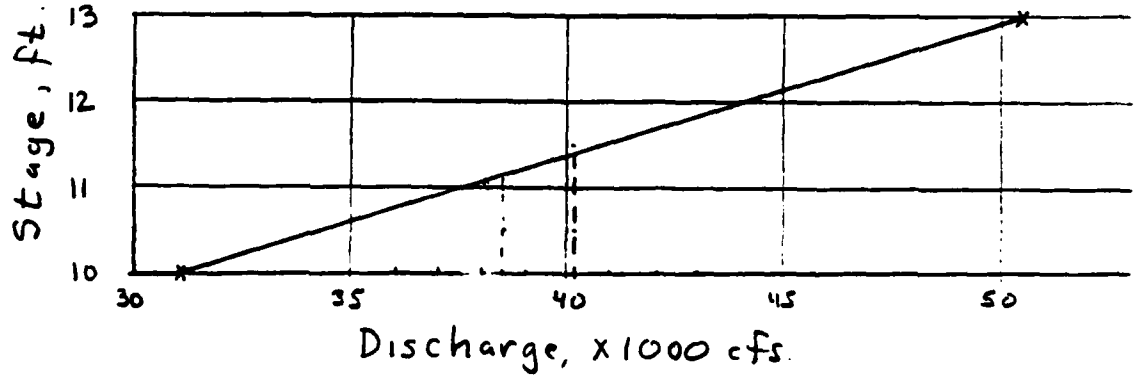
Sta. 13+00 "Swampy" Area

$s = 0.0083'/'$ $\qquad n = 0.10$

$V = f' R^{2/3} \qquad f' = \frac{1.486}{0.10}(0.0083)^{1/2} = 1.35$

$V = 1.35\, R^{2/3}$

D ft	WP Ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev.
10	650	5500	4.18 ✓	1.35	5.65 ✓	31,052 ✓	130
13	680	7495	4.99 ✓	"	6.74 ✓	50,515 ✓	133



$$Q_{P_1} = 40{,}558 \text{ cfs} \qquad d_1 = 11.5' \checkmark$$

JOB NO. 79.206.1
DATE 12/12/79
BY FDD
CH'D BY MA

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BOSTON — WEST HARTFORD

SHEET NO. I20
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

Failure Flood Routing - So. Res. Dam

$Q_{P_1} = 40,558$ cfs $d_1 = 11.5$

$$Vol_1 = \frac{3880 + 6492}{2} \times \frac{700}{43,560} = 83.33 \text{ ac-ft}$$

$$Q_{P_2} = 40,558\left(1 - \frac{83.33}{1500}\right) = 38,307 \text{ cfs} \quad d_2 = 11.1'\pm$$

$$Vol_2 = \frac{3880 + 6111}{2} \times \frac{700}{43,560} = 80.28 \text{ ac-ft}$$

$$Vol_{ave} = \frac{83.33 + 80.28}{2} = 81.82 \pm \text{ac-ft}$$

$$Q_{P_2} = 40,558\left(1 - \frac{81.52}{1500}\right) = 38,356 \pm \text{cfs} \quad d_2 = 11.1'$$

$Q_{out} = 38,356$ cfs Elev = 131.1'

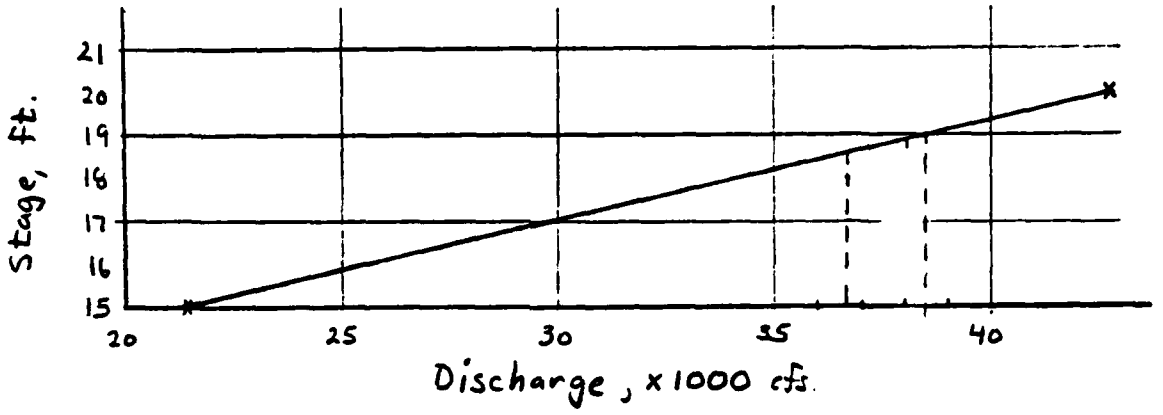
Sta 17+00

$s = 0.0083$ $n = 0.10$

$V = f' R^{2/3}$ $V = 1.35 R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev
10	350	1750	2.94	1.35	3.97	6945	120
15	400	3625	4.38	"	5.91	21,429	125
20	450	5750	5.51	"	7.44	42,788	130

Failure Flood Routing - So. Res. Dam



$Q_{P_1} = 38,356$ cfs $\quad d_1 = 19.0'$

$Vol_1 = \frac{6300 + 5305}{2} \times \frac{400}{43,560} = 53.28$ ac-ft.

$Q_{P_2} = 38,356\left(1 - \frac{53.28}{1500}\right) = 36,994$ cfs. $\quad d_2 = 18.8'$

$Vol_2 = \frac{6308 + 5212}{2} \times \frac{400}{43,560} = 52.88$ ac-ft

$Vol_{ave} = \frac{53.28 + 52.88}{2} = 53.08$ ac-ft

$Q_{P_3} = 38,356\left(1 - \frac{53.08}{1500}\right) = 36,998$ cfs. $\quad d_2 = 18.8'$

$Q_{out} = 36,998$ cfs. $\quad Elev. = 128.8'$

Sta 25+00

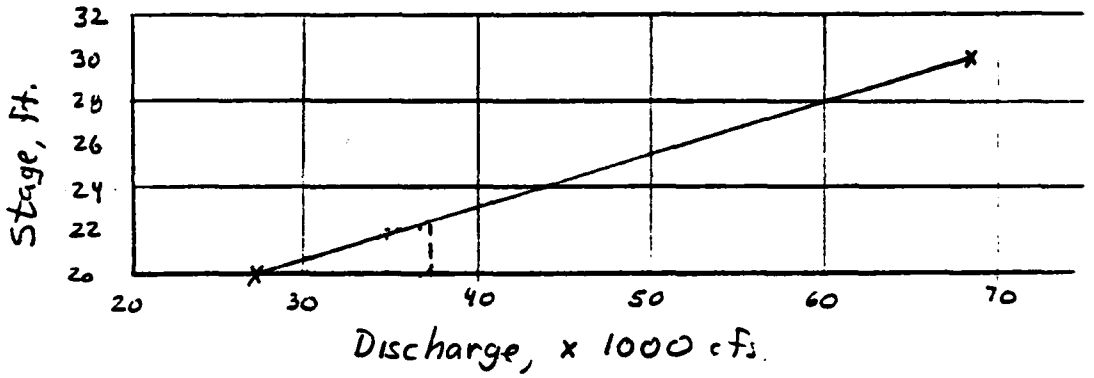
$S = 0.0125\%$ $\quad n = 0.11$

$V = F' R^{2/3} \qquad F' = \frac{1.486}{0.11}(0.0125)^{1/2} = 1.51$

$V = 1.51 R^{2/3}$

Failure Flood Routing - So. Res. Dam

D ft	WP Ft	A sf	$R^{2/3}$	F'	V Fps.	Q cfs	Elev
10	200	1000	2.94 ✓	1.51	4.44 ✓	4,439 ✓	110
20	275	3350	5.34 ✓	"	8.06 ✓	27,005 ✓	120
30	400	6800	6.67 ✓	"	10.08 ✓	68,531 ✓	130



Q_{P_1} = 36,998 cfs d_1 = 22.4'

$$Vol_1 = \frac{5240 + 4030}{2} \times \frac{800}{43,560} = 85.13 \text{ ac-ft} \checkmark$$

$$Q_{P_2} = 36,998 \left(1 - \frac{85.13}{1500}\right) = 34,897 \text{ cfs} \checkmark \quad d_2 = 21.9' \pm$$

$$Vol_2 = \frac{5240 + 3880}{2} \times \frac{800}{43560} = 83.75 \text{ ac-ft} \checkmark$$

$$Vol_{ave} = \frac{85.13 + 83.75}{2} = 84.44 \text{ ac-ft} \checkmark$$

$$Q_{P_3} = 36,998 \left(1 - \frac{84.44}{1500}\right) = 34,901 \pm \text{ cfs} \checkmark \quad d_2 = 21.9' \pm$$

Q_{out} = 34,901 cfs Elev. = 121.9'

JOB NO. 79.206.1
DATE 12/21/79
BY FDD
CH'D BY MA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D23
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

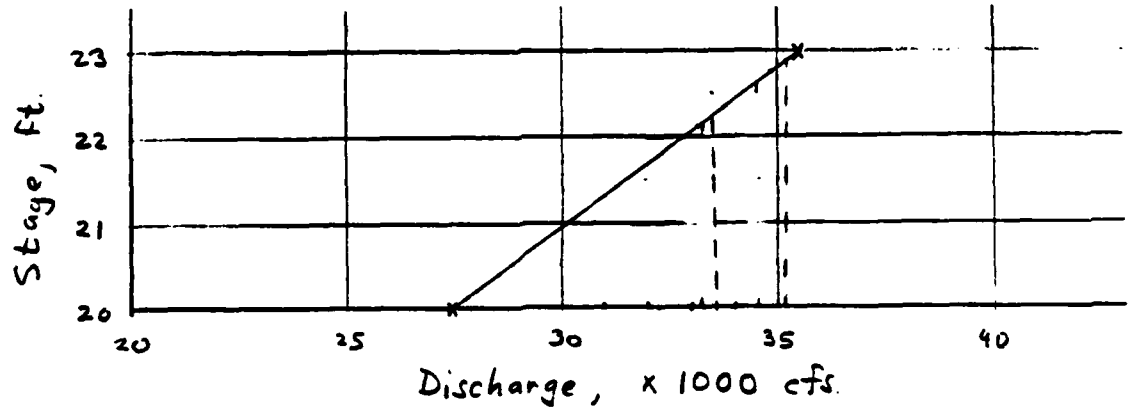
Failure Flood Routing - So. Res. Dam

Sta 33+00

$S = 0.0125$ $n = 0.11$

$V = f' R^{2/3}$ $V = 1.51 R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev
10	200	1006	2.93 ✓	1.51	4.44	4439 ✓	100
20	350	3750	4.90 ✓	"	7.40 ✓	27739 ✓	110
23	760	5940	3.97 ✓	"	5.99 ✓	35,568 ✓	113



$Q_{P_1} = 34,901$ cfs $d_1 = 22.75'$ ✓

$Vol_1 = \frac{3975+5710}{2} \times \frac{700}{43,560} = 77.82$ ac-ft ✓

$Q_{P_2} = 34,901 \left(1 - \frac{77.82}{1500}\right) = 33,090$ cfs ✓ $d_2 = 22.25'$

$Vol_2 = \frac{3975+5314}{2} \times \frac{700}{43,560} = 74.66$ ac-ft ✓

$Vol_{ave} = \frac{77.82+74.66}{2} = 76.24$ ac-ft ✓

Failure Flood Routing - So. Res. Dam

$$Q_{p_3} = 34,901\left(1 - \frac{76.24}{1500}\right) = 33,127 \text{ cfs.} \quad d_2 = 22.2' \pm$$

$$Q_{out} = 33,127 \text{ cfs} \quad Elev. = 112.2' \pm$$

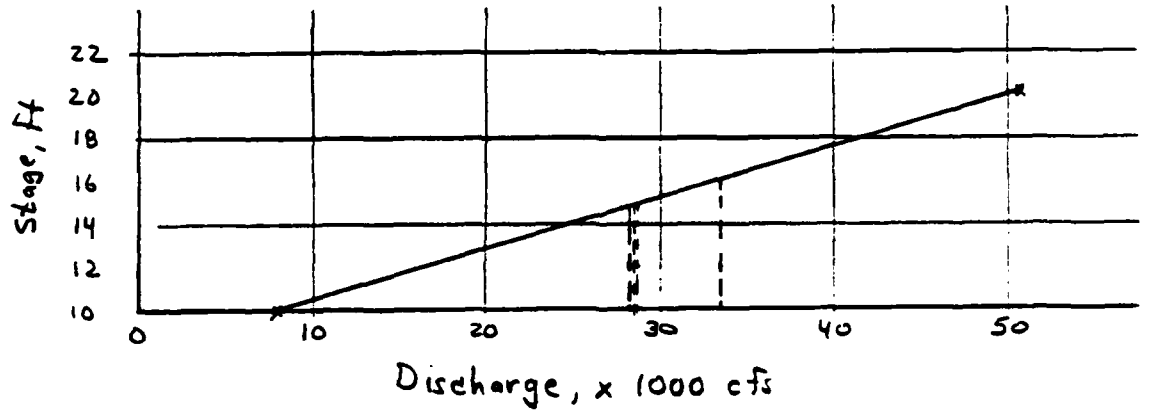
Sta. 50+00

$S = 0.00588$ $\quad n = 0.12$

$V = f' R^{2/3}$ $\quad f' = \frac{1.486}{.12}(0.00588)^{1/2} = 0.950$

$V = 0.95\, R^{2/3}$

D Ft	WP Ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev
10	270	2100	3.93	0.95	3.73	7833	90
20	1200	11,700	4.56	"	4.33	50,661	100



$Q_{p_1} = 33,127$ cfs. $\quad d_1 = 16'$

$$Vol_1 = \frac{5550 + 7284}{2} \times \frac{1700}{43560} = 250.43 \text{ ac-ft}$$

$$Q_{p_2} = 33,127\left(1 - \frac{250.43}{1500}\right) = 27,596 \text{ cfs.} \quad d_2 = 14.7$$

JOB NO. 79.206.1
DATE 12/26/79
BY FDD
CH'D BY MR

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D25
JOB Dams
SUBJECT South Res Dam
CLIENT Corps

Failure Flood Routing - So. Res. Dam

$Q_{P_2} = 27,596 \qquad d_2 = 14.7$

$Vol_2 = \frac{5550+6000}{2} \times \frac{1700}{43560} = 225.38$ ac-ft

$Vol_{ave} = \frac{250.43+225.38}{2} = 237.91$ ac-ft

$Q_{P_3} = 33,127\left(1 - \frac{237.91}{1500}\right) = 27,886$ cfs $\qquad d_2 = 14.8'$

$Q_{P_3} \cong 28000 \pm \qquad El = 95 \pm$

Sta. 59+00

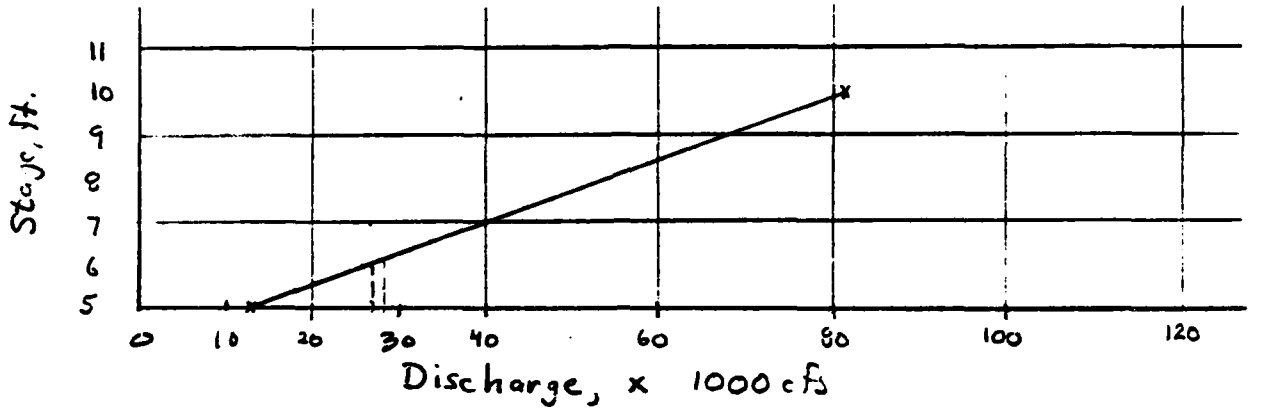
$s = 0.333 \qquad n = 0.12$

$V = f' R^{2/3} \qquad f' = \frac{1.486}{.12}(.333)^{1/2} = 7.14$

$V = 7.14\, R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev.
10	780	3900	2.93 ✓	7.14	20.92 ✓	81599 ±	60
5	390	975	1.84 ✓	"	13.14 ✓	12812 ±	55

Failure Flood Routing - So. Res. Dam



Q_{p_1} = 28,000 cfs. $d_1 = 6.1'$

$Vol_1 = \frac{6250 + 1342}{2} \times \frac{900}{43560} = 78.43$ ac-ft ✓

$Q_{p_2} = 28{,}000\left(1 - \frac{78.43}{1500}\right) = 26{,}560$ cfs ✓ $d_2 = 6.0'$

$Vol_2 = \frac{6250 + 1240}{2} \times \frac{900}{43560} = 77.38$ ac-ft ✓

$Vol_{ave} = \frac{77.38 + 78.43}{2} = 77.91$ ac-ft ✓

$Q_{p_3} = 28{,}000\left(1 - \frac{77.91}{1500}\right) = 26{,}571$ cfs ✓ $d_2 = 6.0'$

$Q_{out} = 26{,}571$ cfs. Elev. = 56.0'

Sta. 73+00

$s = 0.0143$ $n = 0.15$

$V = f' R^{2/3}$ $f' = \frac{1.486}{0.15}(.0143)^{1/2} = 1.19$ ✓

$V = 1.19 R^{2/3}$

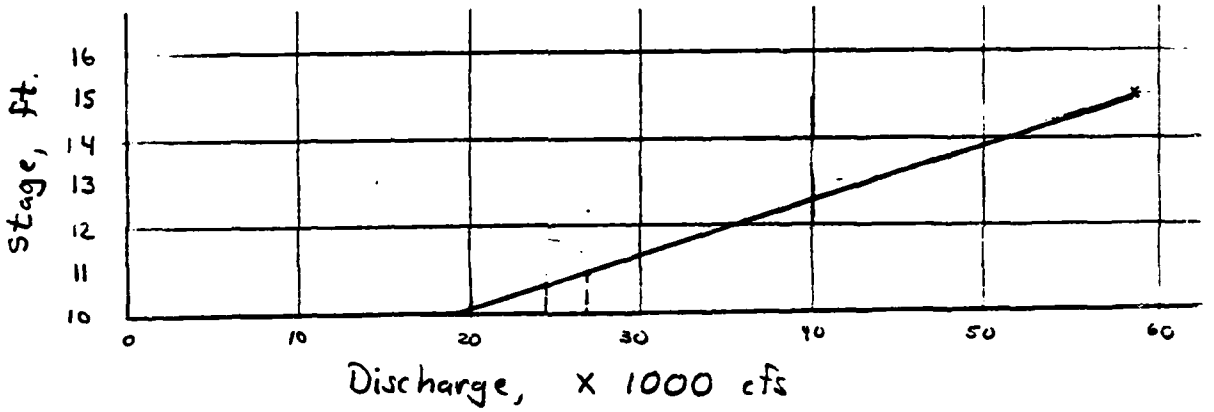
JOB NO. 79.206.1
DATE 12/26/79
BY FDD
CH'D BY WA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D27
JOB Dams
SUBJECT South Res Dams
CLIENT Corps

Failure Flood Routing - So. Res. Dam

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev
10	1100	5500	2.93 ✓	1.19	3.49 ✓	19,195	40
15	1300	11,500	4.28 ✓	"	5.09	58,535	45



Q_{P_1} = 26,571 cfs d_1 = 10.9'

$Vol_1 = \frac{1425 + 5660}{2} \times \frac{1400}{43560} = 113.85$ ✓ ac-ft

$Q_{P_2} = 26,571 \left(1 - \frac{113.85}{1500}\right) = 24,554$ ✓ cfs. d_2 = 10.7'

$Vol_2 = \frac{1425 + 5610}{2} \times \frac{1400}{43,560} = 113.08$ ✓ ac-ft

$Vol_{ave} = \frac{113.85 + 113.08}{2} = 113.47$ ✓ ac-ft

$Q_{P_2} = 26,571 \left(1 - \frac{113.47}{1500}\right) = 24561$ ✓ cfs. d_2 = 10.7'

Q_{out} = 24,561 cfs. Elev. = 40.7'

JOB NO. 79.206.1
DATE 12/20/79
BY FDD
CH'D BY

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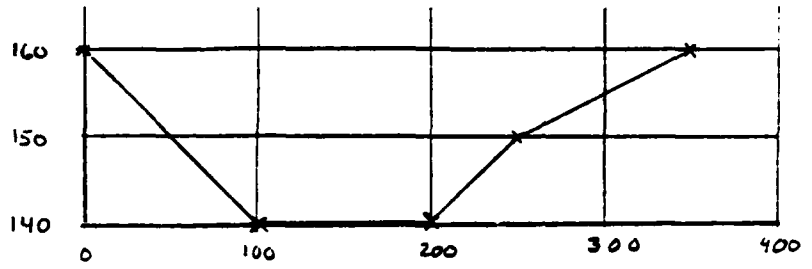
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D28
JOB Dams
SUBJECT South Res
CLIENT Corps

Cross Sections - So. Res. Dam

Sections taken looking upstream

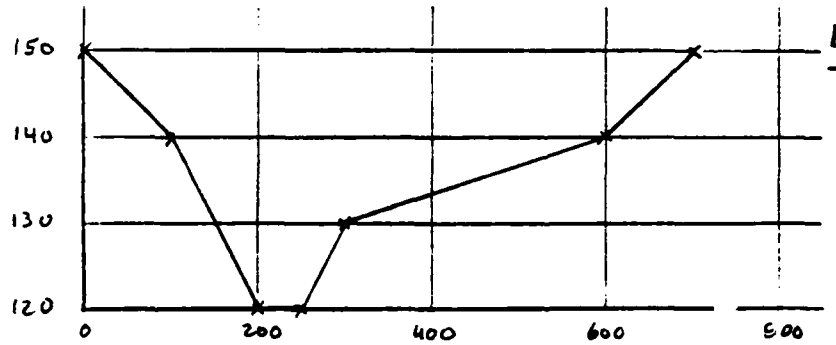
Sta. 3+00 (below Spillway)



Elev. NGVD	Area sf
150	1500
160	4250

$S = 30/600' = 0.05'/'$ $n = 0.12$ - med.-hvy. brush & trees.

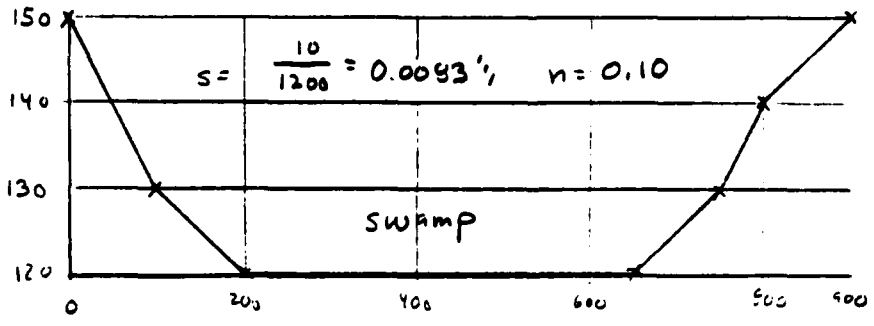
Sta 6+00 (below Dam)



Elev.	Area sf
130	1000
140	4250
150	10250

$S = 0.05$ $n = 0.12$

Sta 13+00



Elev.	Area sf
130	5500
140	12500
150	20750

JOB NO. 79.206.1
DATE 12/20/79
BY EDD
CH'D BY MR

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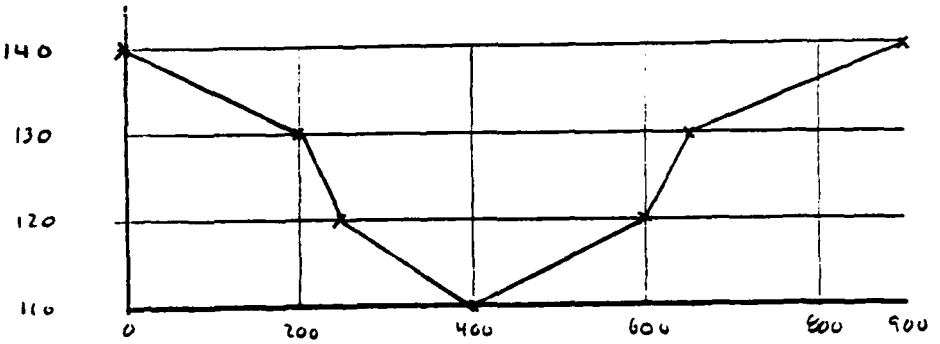
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D29
JOB Dams
SUBJECT South Res
CLIENT Corps

Cross Sections - South Res Dam

Sections taken looking upstream

Sta 17+00



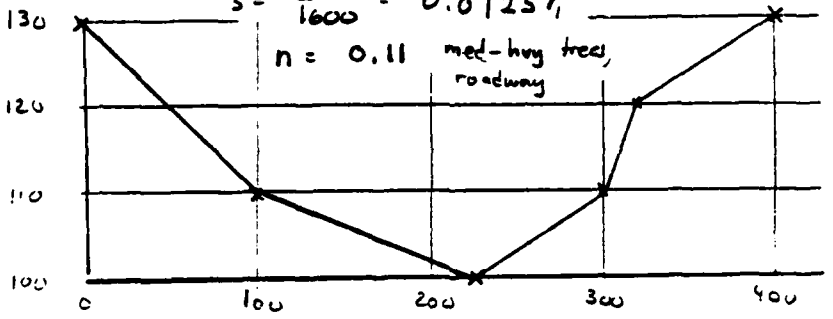
Elev	Area sf
120	1750
130	5750
140	12,000

$S = 0.0083\%$ $n = 0.10$

Sta 25+00

$S = \frac{20}{1600} = 0.0125\%$

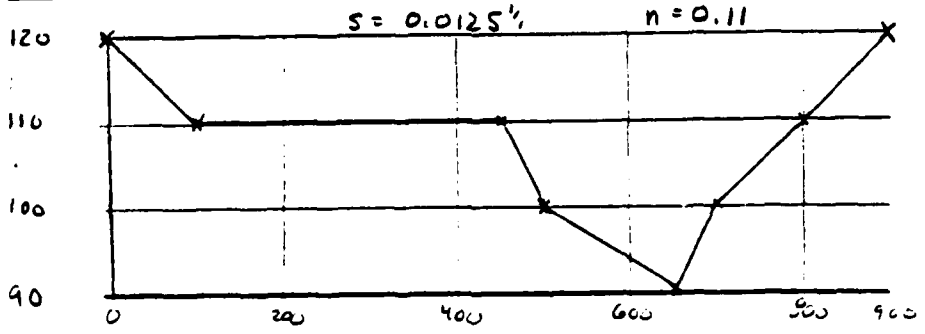
$n = 0.11$ med-hvy trees, roadway



Elev	Area sf
110	1000
120	3350
130	6800

Sta 33+00

$S = 0.0125\%$ $n = 0.11$

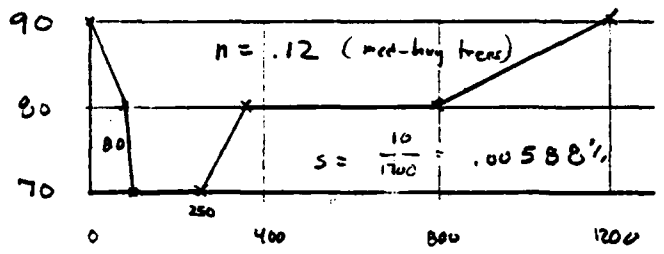


Elev	Area sf
100	1000
110	3750
120	10,000

Cross Sections - South Res. Dam

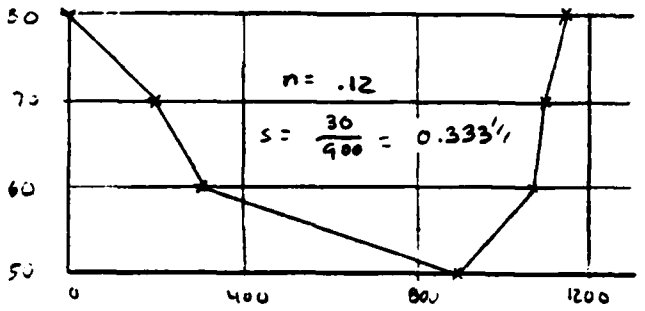
Sections taken looking upstream

Sta. 50+00 (below Dam)



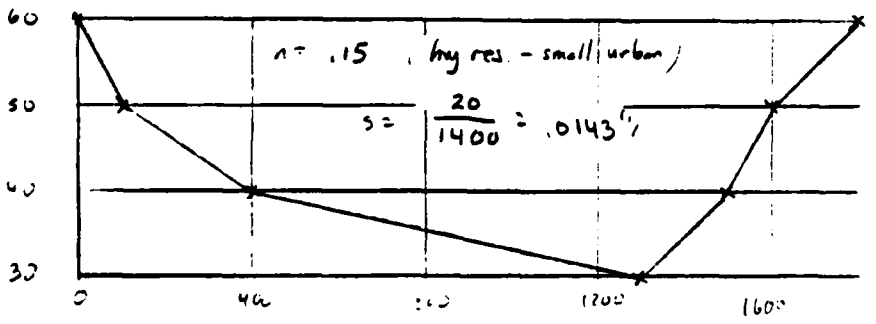
Elev.	Area (sF)
90	2,100
100	11,700

Sta 59+00



Elev.	Area (sf)
60	3,900
70	12,300
80	22,550

Sta. 73+00



Elev	Area sf
40	5,500
50	19,500
60	35,000

West Dike - located at southwest corner of South Reservoir

has length approx. 200'
height: effective height = 3' as dike crest is about 3' above South Border Rd. (assume this road doesn't washout).

Failure Discharge (From Corps Guidelines):

$$Q_F = \frac{8}{27} \times (0.4 \times 200)(\sqrt{2g})(3)^{1.5} = 698 \text{ cfs}$$

say $Q_F = 700$ cfs.

$Stor = Stor_{163.5} - Stor_{160\pm} = 300$ ac-ft ±
($Stor_{163.5}$: top of dam; $Stor_{160\pm}$: Failure Depth)

Sta 5+00

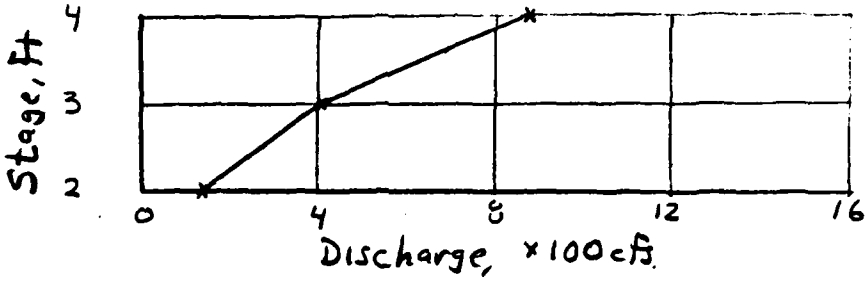
$s = 0.006'/'$ $\quad n = 0.10$

$V = f' R^{2/3}$ $\quad f' = \frac{1.486}{0.10} \times (.006)^{1/2} = 1.15$ ✓

$V = 1.15 R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev.
3	180	270	1.31 ✓	1.15 ✓	1.51 ✓	407 ✓	163
4	240	480	1.59 ✓	"	1.93 ✓	878 ✓	164
2	120	120	1.0	"	1.15	138 ✓	162

Sta. 5+00



$Q_F = 700$ cfs

$d = 3.5'$

Elev = 163.5' ±

$Q_{P_1} = 700$ $d_1 = 3.5'$ $Stor_1 = \frac{389 \times 500}{43560} = 4.47$ ac-ft ✓

$Q_{P_2} = 700\left(1 - \frac{4.47}{300}\right) = 690$ cfs ✓ $d_2 = 3.5'$

$Q_{out} = 690$ cfs Elev = 163.5' ±

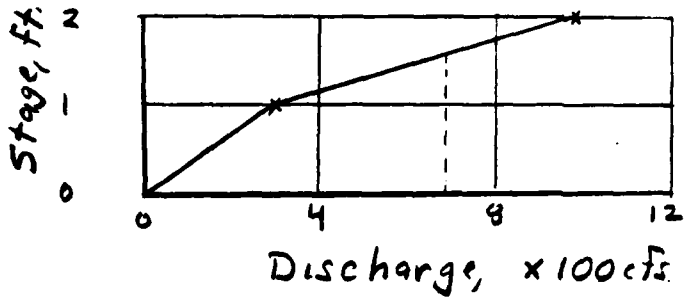
Sta 39+00

$S = 0.018\%$ $\quad n = 0.10$

$V = f' R^{2/3} \qquad f' = \frac{1.486}{0.10}(0.018)^{1/2} = 1.99$ ✓

$V = 1.99\, R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev
1	165	157.5	0.97 ✓	1.99	1.93 ✓	304 ✓	91
2	180	330	1.50	"	2.99 ✓	986 ✓	92



$Q_{P_1} = 690$ cfs $\qquad d_1 = 1.6' \pm$

$\text{Stor}_1 = \frac{389 + 259}{2} \times \frac{3400}{43560} = 25.29$ ac-ft ✓

$Q_{P_2} = 690\left(1 - \frac{25.29}{300}\right) = 632$ cfs ✓ $\qquad d_2 = 1.5' \pm$

$Q_{out} = 632$ cfs $\qquad$ Elev $= 91.5' \pm$

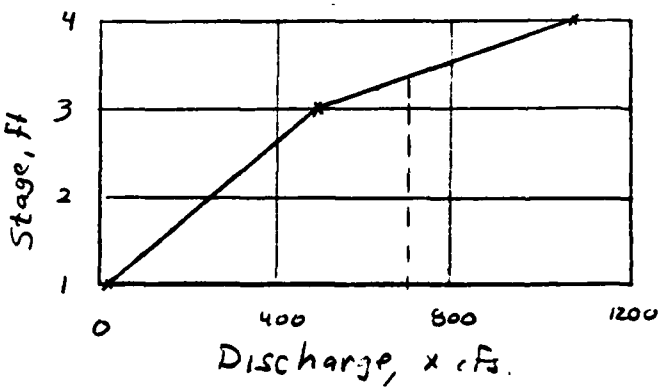
Sta. 52+00

$S = 0.02'/_{'}$ $\quad n = 0.10$

$V = f' R^{2/3}$ $\quad f' = \frac{1.486}{0.1}(0.02)^{1/2} = 2.10$ ✓

$V = 2.10\, R^{2/3}$

D Ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev.
1.0	40	20	.63 ✓	2.10	1.32 ✓	26 ✓	61
3.0	120	180	1.31 ✓	"	2.76 ✓	496 ✓	63
4.0	160	320	1.59 ✓	" ✓	3.34 ✓	1069 ✓	64



$Q_{P_1} = 632$ cfs $\quad d_1 = 3.25'$

$Stor_1 = \frac{250 + 211}{2} \times \frac{1300}{43560} = 6.88$ ac-ft ✓

$Q_{P_2} = 632\left(1 - \frac{6.88}{300}\right) = 618$ cfs ✓ $\quad d_2 = 3.2' \pm$

$Q_{out} = 618$ cfs $\quad$ Elev = $63.2' \pm$

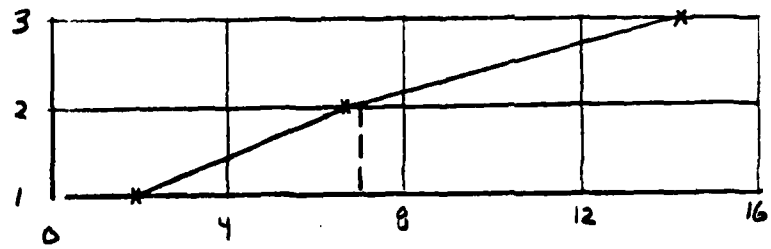
Sta 60+00

$S = 0.014'/_1$ $\quad n = 0.10$ ✓

$V = F' R^{2/3}$ $\quad F' = \frac{1.486}{0.1}(0.014)^{1/2} = 1.76$ ✓

$V = 1.76 R^{2/3}$

D Ft	WP Ft	A sf	$R^{2/3}$	F'	V fps	Q cfs	Elev
2	180	280	1.34 ✓	1.76	2.37 ✓	663 ✓	52
3	220	480	1.69 ✓	" ✓	2.97 ✓	1425 ✓	53
1	140	120	0.90 ✓	"	1.59 ✓	190 ✓	51



$Q_{P_1} = 618$ cfs $\quad d_1 = 1.9'$

$Stor_1 = \frac{210+262}{2} \times \frac{800}{43560} = 4.33$ ✓

$Q_{P_2} = 618\left(1 - \frac{4.33}{300}\right) = 609$ cfs. ✓ $\quad d_2 = 1.9' \pm$

$Q_{out} = 609$ cfs. $\quad Elev = 51.9' \pm$

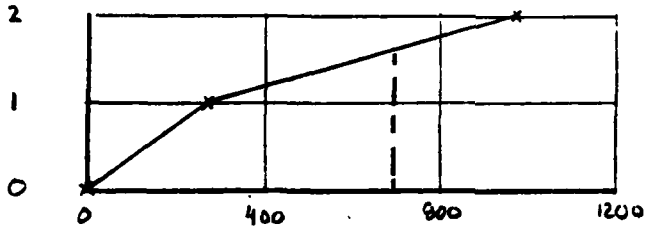
Sta. 70+00

$S = 0.02$ $n = 0.12$

$V = f' R^{2/3}$ $f' = \frac{1.486}{0.12}(0.02)^{1/2} = 1.75$ ✓

$V = 1.75\ R^{2/3}$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev.
2	260	410	1.36 ✓	1.75	2.37 ✓	974 ✓	32
1	205	177.5	0.91 ✓	"	1.59 ✓	293 ✓	31



$Q_{p_1} = 609$ cfs $d_1 = 1.5'$

$Stor_1 = \frac{262+287}{2} \times \frac{1000}{43560} = 6.30$ ac.-ft ✓

$Q_{p_2} = 609\left(1 - \frac{6.30}{300}\right) = 596$ cfs $d_2 = 1.45' \pm$

$Q_{out} = 596$ cfs Elev = $31.5' \pm$

JOB NO. 79.206.1
DATE 11/5/80
BY FDD
CH'D BY

HH&B HAYDEN, HARDING & BUCHANAN, INC
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D37
JOB Dams
SUBJECT South Rec. Dike
CLIENT Corps

Summary of Failure Flood Elevation

Sta.	Ground Elev.	Flood Elev.	Flood Depth
5+00	160 ±	163.5	3.5' ±
39+00	90 ±	91.5	1.5' ±
52+00	60 ±	63.2	3.2' ±
60+00	50 ±	51.9	1.9' ±
70+00	30 ±	31.5	1.5' ±

In residential areas, flooding 3' to 2' or less deep.

Estimate 5-10 houses in impact area.

JOB NO. 79.206.1
DATE 11/15/80
BY EDD
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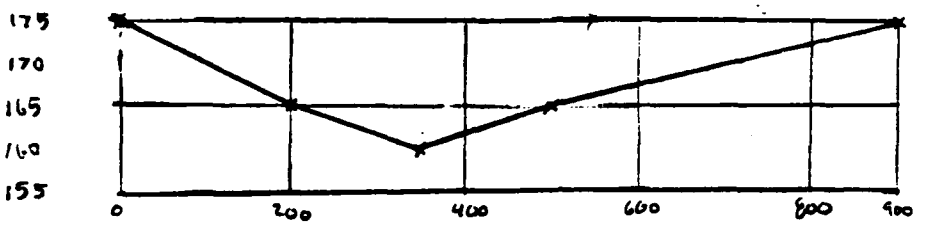
BOSTON — WEST HARTFORD

SHEET NO D28
JOB Dams
SUBJECT South Rec. Dike
CLIENT Corps

Cross Sections - West Dike
(taken looking upstream

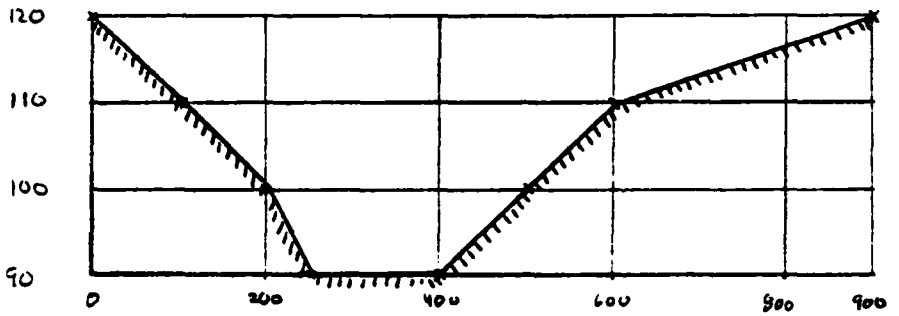
Sta. 5+00



Elev.	Area (sf)
165	750
175	6750

$S = \frac{3'}{500} = 0.006'/_{'}$ $\quad n = 0.10$

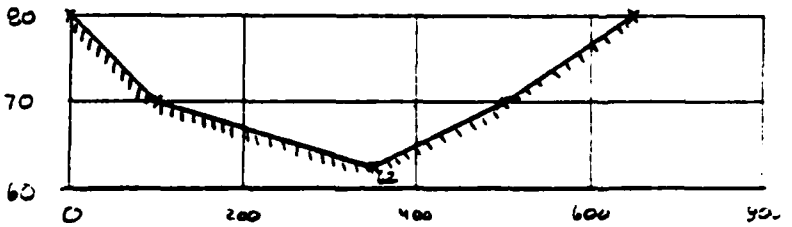
Sta 39+00



Elev,	Area, (sf)
100	2250
110	6250
120	13250

$S = \frac{60}{3300} = 0.018'/_{'}$ $\quad n = 0.10$

Sta. 52+00



Elev.	Area (sf)
70	1600
80	6850

$S = \frac{30}{1500} = 0.02'/_{'}$ $\quad n = 0.10$

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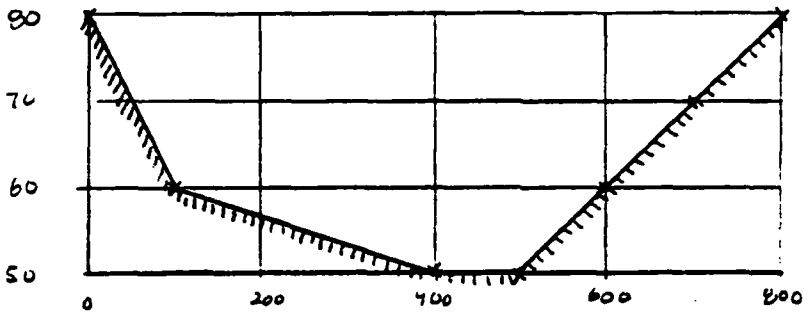
SHEET NO D39
JOB Dams
SUBJECT South Res. Dike
CLIENT Corps

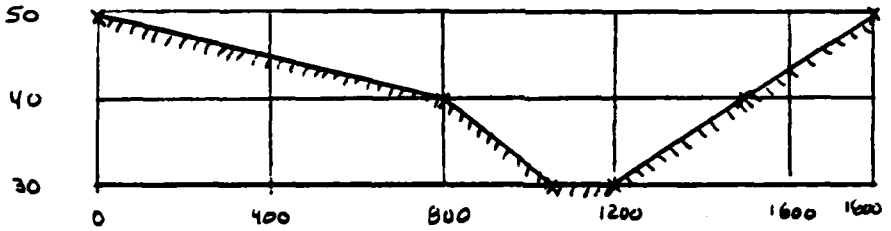
Sta 60+00



Elev	Area (sf)
60	3000
70	8750

$S = \frac{10}{700} = 0.014$ ft/ft $n = 0.10$

Sta 70+00



Elev	Area (sf)
40	4250
50	16750

$S = \frac{20}{1000} = 0.02$ ft/ft $n = 0.12$

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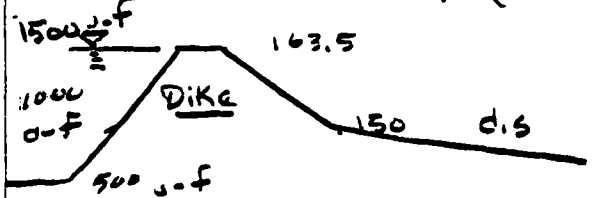
East Dike

Assume dike between South & Middle Res. does not fail.

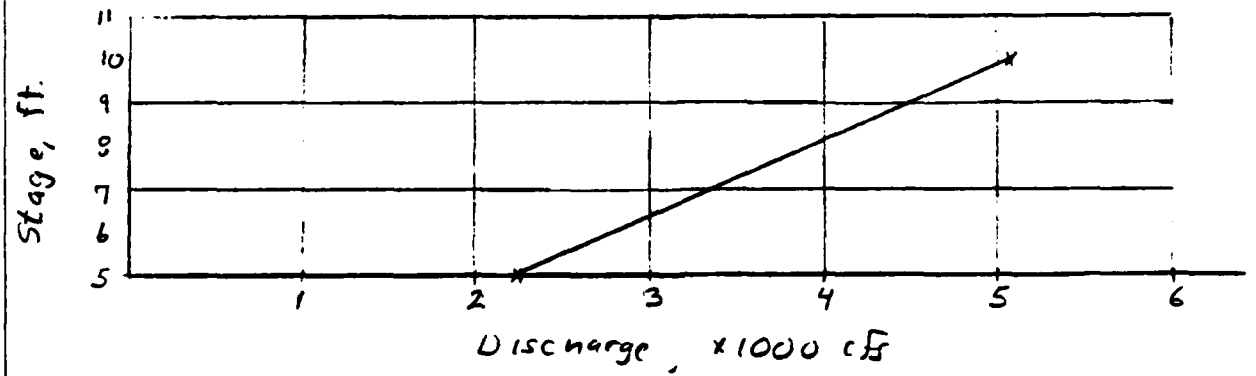
Failure outflow

$$Q = \frac{\varepsilon}{27} \times (0.4 \times 100)(5.67)(13.5)^{3/2} = 3333 \text{ cfs}$$ ✓



@ Sta. 1+50 $\quad F' = \frac{1.486}{0.12}(0.007)^{1/2} = 1.04$ ✓

D Ft.	WP Ft.	A sf.	$R^{2/3}$	F'	V Fps	Q cfs	Elev. NGVD
20	290	3725	5.53 ✓	1.04	5.75 ✓	21,419 ✓	170
5	95	613	3.49	"	3.63	2,223	155
10	190	1325	3.67	"	3.82	5,062	160



$Q_{p_1} = 3333$ cfs $\quad d_1 = 7.0 \pm \quad El = 157.0$

$$Stor_1 = \frac{991 \times 150}{43560} = 3.4 \text{ ac-ft}$$ ✓

$$Q_{p_2} = 3333\left(1 - \frac{3.4}{1000}\right) = 3322 \pm \text{ cfs}$$

Q_{P_2} = 3322 cfs d_2 = 7.0 El = 157.0

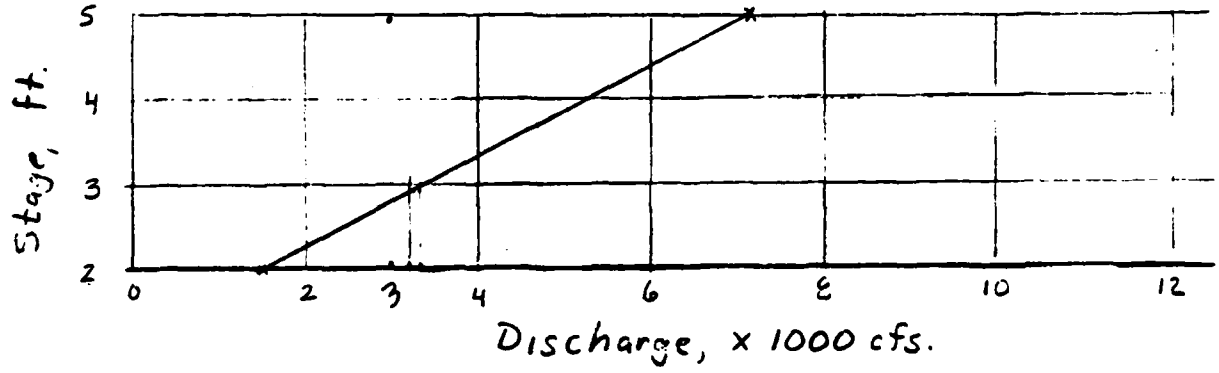
$Stor_2$ = 3.4 ac-ft

$Stor_{av}$ = 3.4

Q_{out} = 3322 cfs El = 157.0

@ Sta. 15+00 F' = 1.04

D (ft)	WP (ft)	A (sf)	$R^{2/3}$	F'	V (fps)	Q (cfs)	Elev. NGVD
10	650	5500	4.18	1.04	4.34	23870	160
2	990	940	1.55	"	1.61	1513	152
5	550	2500	2.76	"	2.87	7171	155



Q_{P_1} = 3322 cfs d_1 = 3.0' El = 153.0'

$Stor_1 = \frac{941 + 1440}{2} \times \frac{1350}{43560} = 37.7$ ac-ft

$Q_{P_2} = 3322 \left(1 - \frac{37.7}{1000}\right) = 3197$ cfs

Q_{P_2} = 3197 cfs d_2 = 2.9' Elev = 152.9 ±

$Stor_2 = \frac{991 + 1415}{2} \times \frac{1350}{43560} = 37.3$ ac-ft

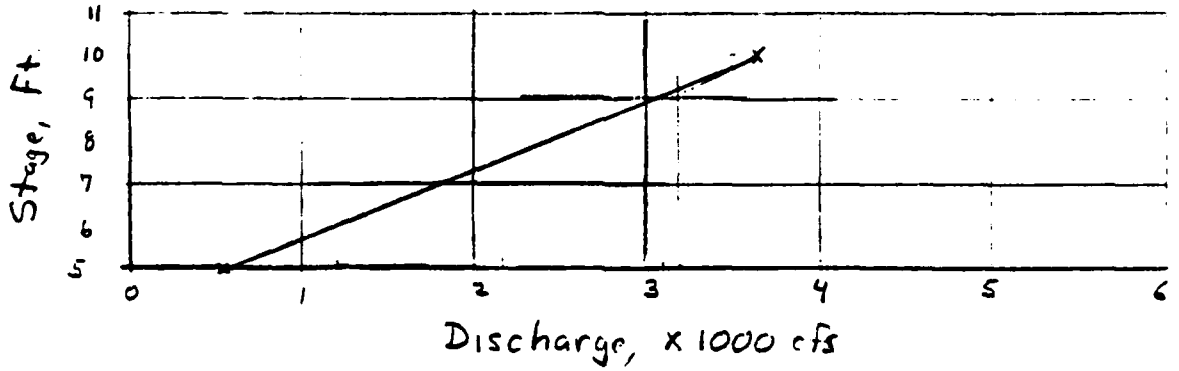
$Stor_{ave} = \frac{37.7 + 37.3}{2} = 37.5$ ac-ft

$Q_{P_3} = 3322\left(1 - \frac{37.5}{1000}\right) = 3197$ cfs

Qout = 3197 cfs Elev = 152.9' ±

@ Sta 25+00 $f' = \frac{1.486}{0.12}(.01)^{1/2} = 1.24$

D ft	WP ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev NGVD
10	200	1000	2.94	1.24	3.65	3650	150
5	100	250	1.85	"	2.3	572	145
15	350	2900	3.90	"	4.84	14,034	155



Q_{P_1} = 3197 cfs d_1 = 9.2' Elev = 149.2' ±

$Stor_1 = \frac{1425 + 846}{2} \times \frac{1000}{43560} = 26.1$ ac-ft

$$Q_{P_2} = 3197\left(1 - \frac{26.1}{1000}\right) = 3114 \text{ cfs}$$

$Q_{P_2} = 3114$ cfs $\quad d_2 = 9.\ldots \quad Elev = 149.$

$$Stor_2 = \frac{1425+637}{2} \times \frac{1000}{43560} = 26.0 \text{ ac-ft}$$

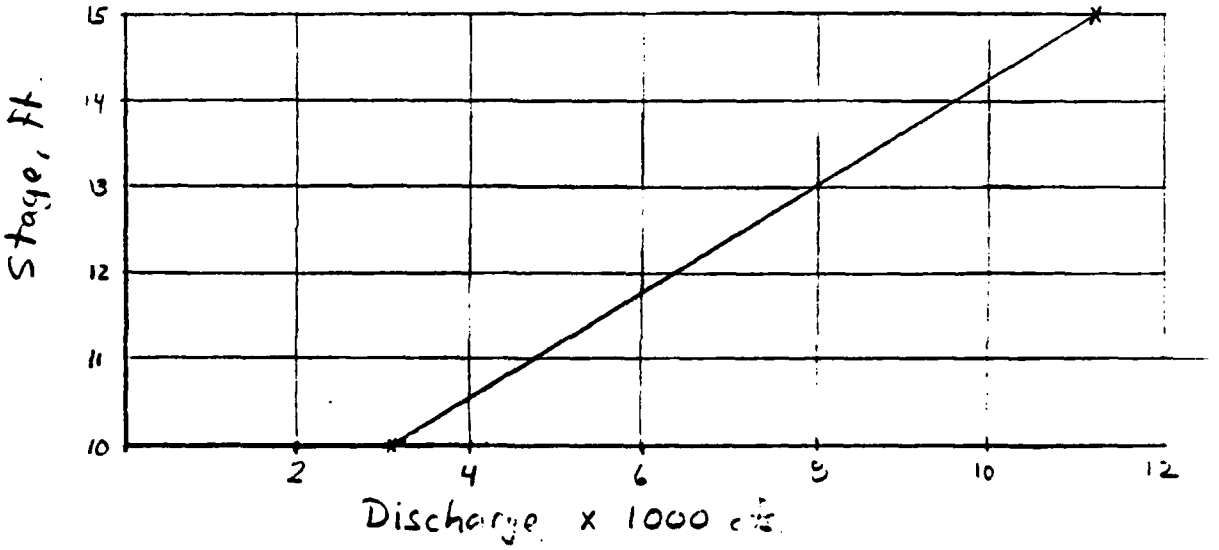
$$Stor_{ave} = \frac{26.0+26.1}{2} = 26.05 \text{ ac-ft}$$

$$Q_{P_3} = 3197\left(1 - \frac{26.05}{1000}\right) = 3113 \text{ cfs}$$

$Q_{out} = 3113$ cfs $\quad Elev. = 149.\pm$

@ Sta 33+00 $\quad f' = \frac{1.486}{0.12}(0.013)^{1/2} = 1.41$

D ft	WP Ft	A sf	$R^{2/3}$	f'	V fps	Q cfs	Elev NGVD
20	300	3000	4.68	1.41	6.60	19,796	140
15	275	2063	3.86	"	5.44	11,220	135
10	150	750	2.94 ✓	"	4.15 ✓	3109 ✓	130



$Q_{P_1} = 3113$ cfs $\quad d_1 = 10.\pm \quad$ Elev = 130.'

$$Stor_1 = \frac{840+765}{2} \times \frac{800}{43560} = 14.7 \text{ ac-ft.}$$

$$Q_{P_2} = 3113\left(1 - \frac{14.7}{1000}\right) = 3067 \text{ cfs}$$

$Q_{P_2} = 3067$ cfs $\quad d_2 = 10\pm$ Elev = 130

$Stor_2 = Stor_1 = Stor_{ave} = 14.7$ ac-ft.

$Q_{out} = 3067$ cfs. $\quad$ Elev = 130.1'±

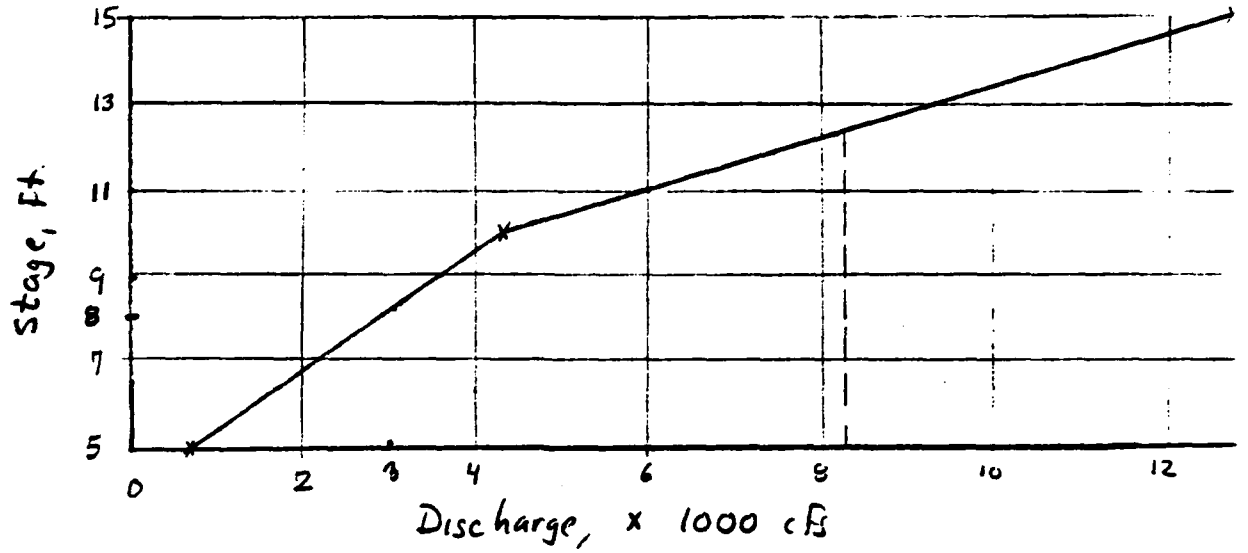
@ Sta 41+00 $\quad F' = \frac{1.486}{0.12}(0.025)^{1/2} = 1.96$ ✓

D / ft	WP / ft	A / sf	$R^{2/3}$	F'	V / fps	Q / cfs	Elev / NGVD
10	150	750	2.94 ✓	1.96	5.76 ✓	4322 ✓	110
20	300	3000	4.68	"	9.17	27,518	120
15	225	1688	3.86	"	7.56	12,762	115
5	75	187.5	1.85	"	3.62	679	105

JOB NO. 79.206.1
DATE 11/25/90
BY EDD
CH'D BY MK

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D45
JOB Dams
SUBJECT South Rec Dike
CLIENT Corps



$Q_{P_1} = 3067$ cfs $d_1 = 8.2'$ Elev = 108.2'

$Stor_1 = \frac{765 + 529}{2} \times \frac{800}{43560} = 11.9$ ✓ ac-ft

$Q_{P_2} = 3067\left(1 - \frac{11.9}{1000}\right) = 3030.$ cfs

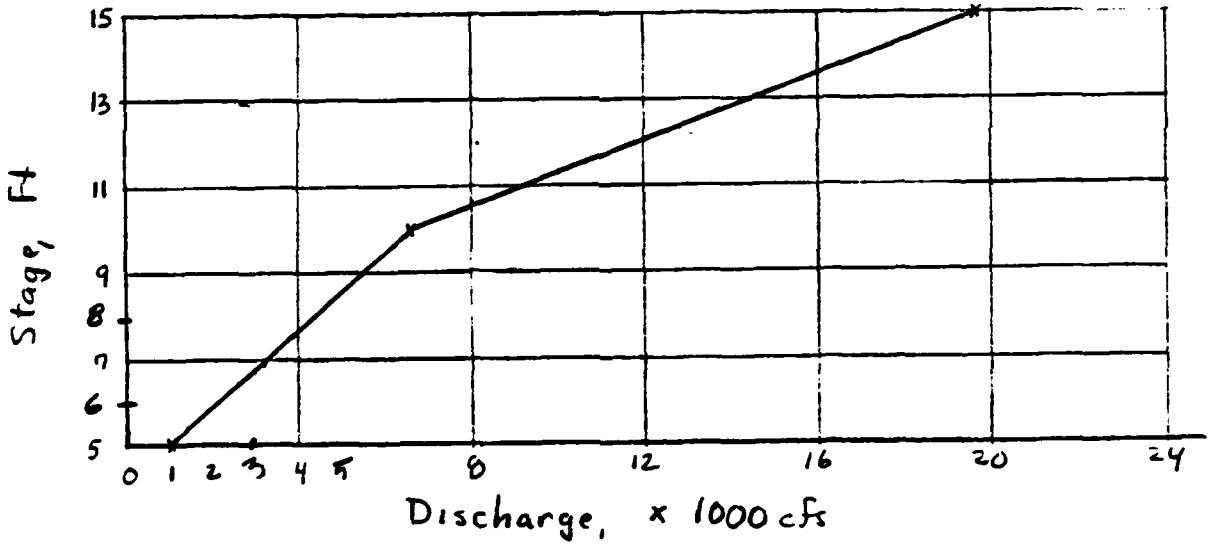
$Q_{P_3} = 3030$ cfs $d_2 = 8.2$ Elev = 108.2'

$Q_{P_3} \simeq 3030$ cfs Elev = 108.2

@ Sta. 50+00

$$F' = \frac{1.486}{a^{1/2}} (0.033)^{1/2} = 2.25 \checkmark$$

D (Ft)	WP (Ft)	A (sF)	$R^{2/3}$	F'	V (fps)	Q (cfs.)	Elev (NGVD)
10	200	1000	2.94 ✓	2.25	6.61 ✓	6,614 ✓	80
5	100	250	1.85	"	4.16	1,039	75
15	275	2188	4.01	"	9.03	19,753	85



$Q_{P_1} = 3030$ cfs $\quad d_1 = 6.9 \quad Elev = 76.9'$

$$Stor_1 = \frac{526+476}{2} \times \frac{900}{43560} = 10.4 \checkmark \text{ ac-ft}$$

$$Q_{P_2} = 3030\left(1 - \frac{10.4}{1000}\right) = 2998 \text{ cfs.} \quad d_1 = 6.9' \pm$$

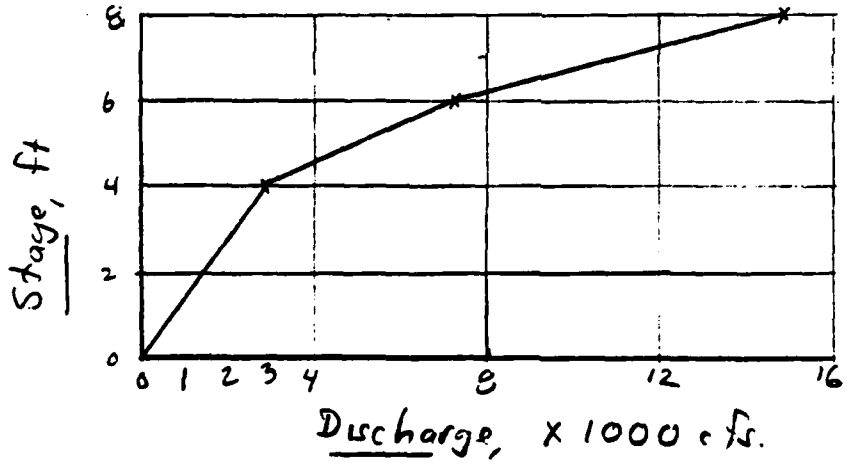
$Stor_2 = Stor_1 = Storage = 10.4$ ac-ft

$Q_{out} = 3000 \pm$ cfs. $\quad Elev = 76.9' \pm$

@ Sta. 55+00

$$F' = \frac{1.486}{0.10} \times (.01)^{1/2} = 1.49 \checkmark$$

D	WP	A	$R^{2/3}$	F'	V	Q	Elev
ft.	ft	sf			fps	cfs	NGVD
4	430	1060	1.83 ✓	1.49	2.73 ✓	2891 ✓	69
6	600	2100	2.31	"	3.45	7243	73
8	660±	3360±	2.98	"	4.43	14896	72±



Q_{p_1} = 3,000 cfs. d_1 = 4.2' ✓ Elev = 68.2'

$$Stor_1 = \frac{476 + 1155}{2} \times \frac{500}{43560} = 9.4 \checkmark \text{ ac-ft}$$

$$Q_{p_2} = 3000\left(1 - \frac{9.4}{1000}\right) = 2972 \checkmark \text{ cfs} \quad d_2 = 4.2'$$

$Stor_2 = Stor_1 = Stor_{ave}$ = 9.4 ac-ft.

Q_{out} = 2972 cfs Elev = 68.2

OB NO. 79.206.1
ATE 1/29/80
Y [illegible]
H'D BY MA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D4.9
JOB Dam
SUBJECT South Fork Dike
CLIENT Corps

Impact Area:

Sta 0+00 to 41+00. No development. No damage to any man-made structures

Sta. 41+00 to 55+00 Overtops South Border Road by 2-3 feet. Could get houses across road from stream by say 2-3 feet.

Beyond Sta. 55+00: Drainage path leads to densely settled residential area with some small businesses. Depth of failure outflow on order 1-2' (slight ridge around Sta. 60+00) Minor to moderate damage to at least 10-20 houses (estimated)

JOB NO. 79.206.1
DATE 11/25/80
BY FDD
CH'D BY MA

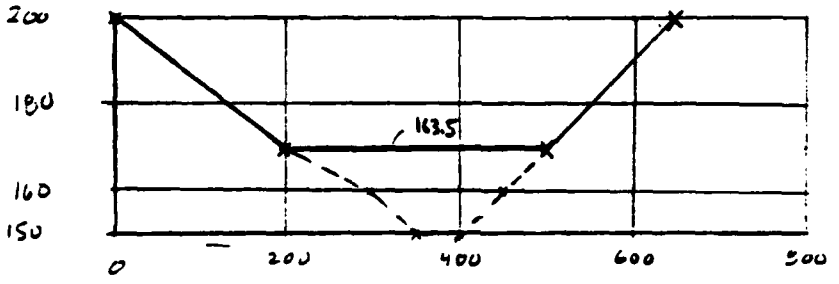
HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D49
JOB Dams
SUBJECT South Bay Dike
CLIENT Corps

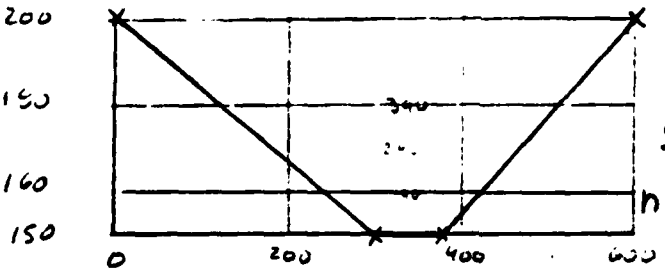
East Dike

X-sections (looking U/S)

Dike



Sta 1+50' downstream



$S = \frac{10}{1500} = .007$

$n = 0.12$ (swamp, forested)

Elev NGVD	Area
160	1325
170	3725
160	7125

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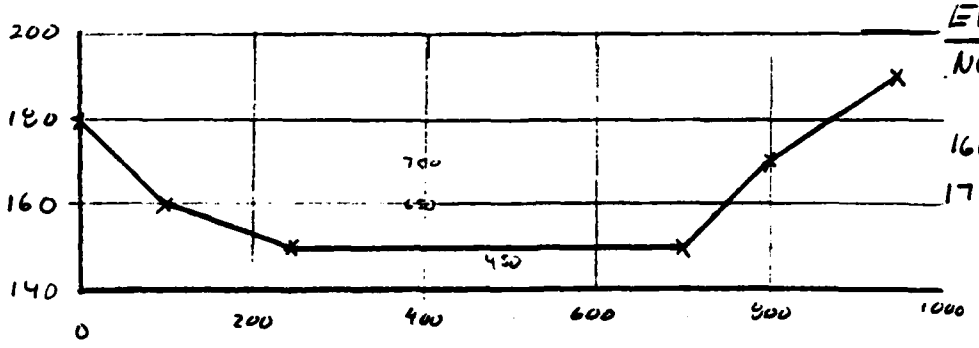
BOSTON — WEST HARTFORD

X-Sections (looking U/S)

Sta. 15+00' downstream

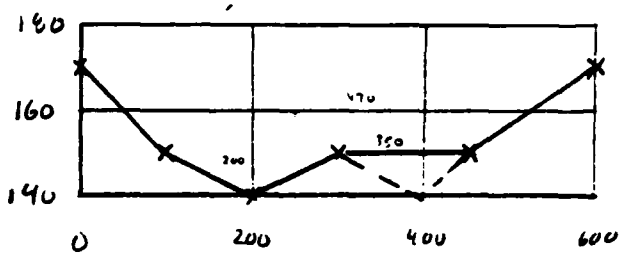


Elev NGVD	Area sf
160	5500
170	12500

$S = 0.007'$

$n = 0.12$

Sta. 25+00

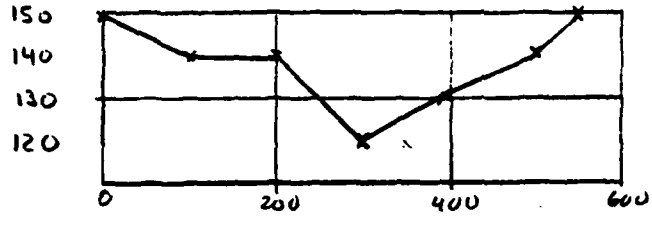


Elev. NGVD	Area sf.
150	1000
160	5100
170	10450

$S = \frac{10}{1000} = 0.01'$

$n = 0.12$

@ 33+00 ' downstream

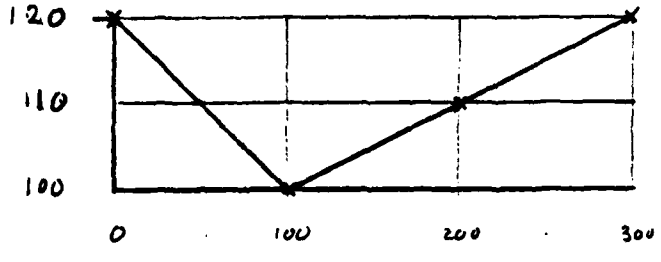


Elev. NGVD	Area sf
130	750
140	3000
150	7750

$S = \frac{10}{800} = 0.013$

$n = 0.12$

@ 41+00' downstream

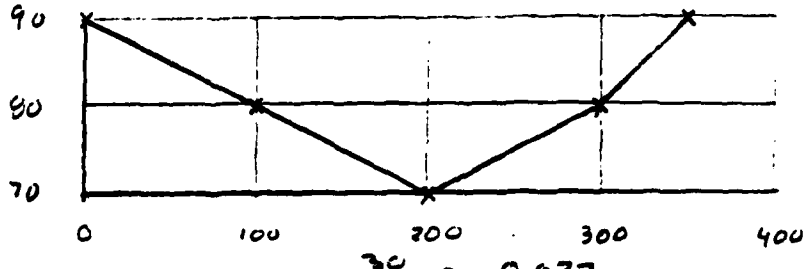


Elev NGVD	Area sf
110	750
120	3000

$S = \frac{20}{600} = 0.025$

$n = 0.12$

@ 50+00 ' downstream



Elev. NGVD	Area sf
80	1000
90	3500

$S = \frac{30}{900} = 0.033$

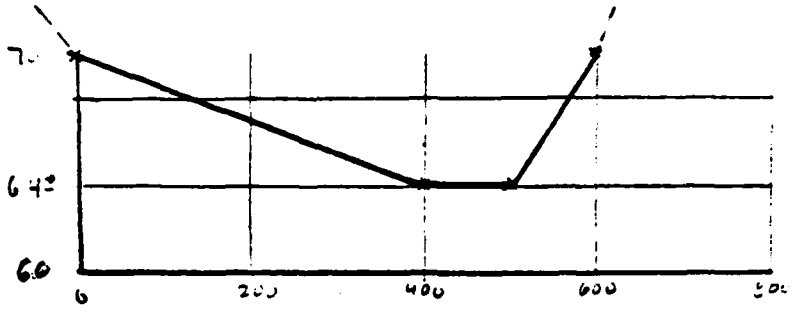
$n = 0.12$

JOB NO. 79.706.1
DATE 11/26/80
BY FDD
CH'D BY

HH&B HAYDEN, HARDING & BUCHANAN, INC
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

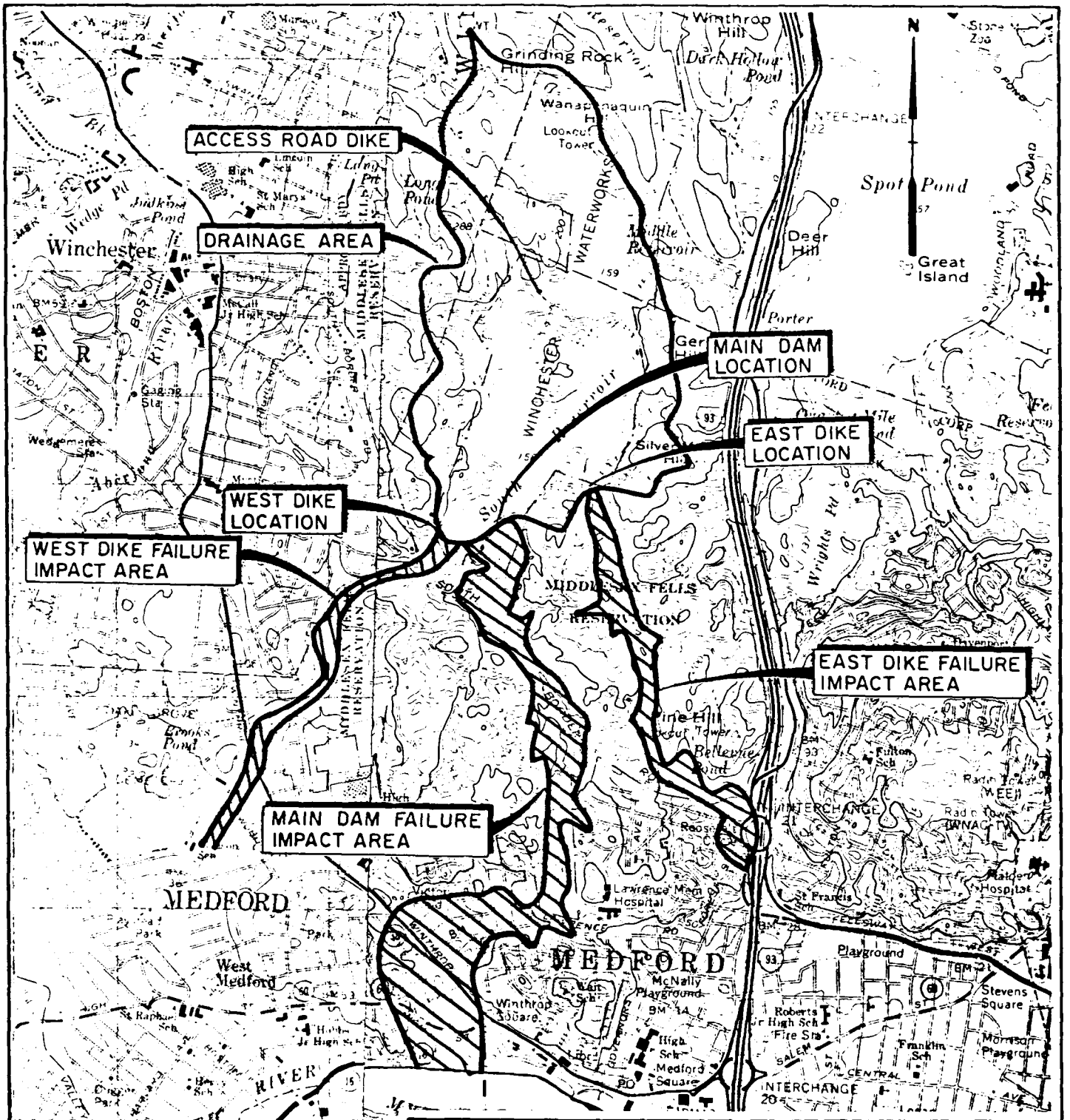
SHEET NO. D 52
JOB Dams
SUBJECT South Bend Dike
CLIENT Corps

Sta. 55+00



Elev NGVD	Area sf
68	1060
70	2100
72	3360

$S = \frac{10}{1000} = 0.01\%$ $\quad n = 0.10$



HAYDEN, HARDING & BUCHANAN, INC
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

U.S ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SOUTH RESERVOIR DAM
DAM & DIKES FAILURE IMPACT & DRAINAGE AREAS

WINCHESTER MASSACHUSETTS

SCALE 1:24000 & 1:25000

DATE MARCH 1980

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

END

FILMED

7-85

DTIC